Alpine Satellite Development Plan for the Proposed Greater Mooses Tooth 2 Development Project

Final Supplemental Environmental Impact Statement

Volume 3a: Appendices A-N

Prepared by:

U.S. Department of the Interior
Bureau of Land Management
Anchorage, AK

In cooperation with:

Native Village of Nuiqsut
U.S. Army Corps of Engineers
U.S. Environmental Protection Agency
U.S. DOI Fish and Wildlife Service
U.S. DOI Bureau of Ocean Energy Management
State of Alaska
North Slope Borough
Inupiat Community of the Arctic Slope

August 2018

Total Cost of Producing the EIS: $1.1 Million.

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APPENDIX A

PERMIT DRAWINGS PACKAGE

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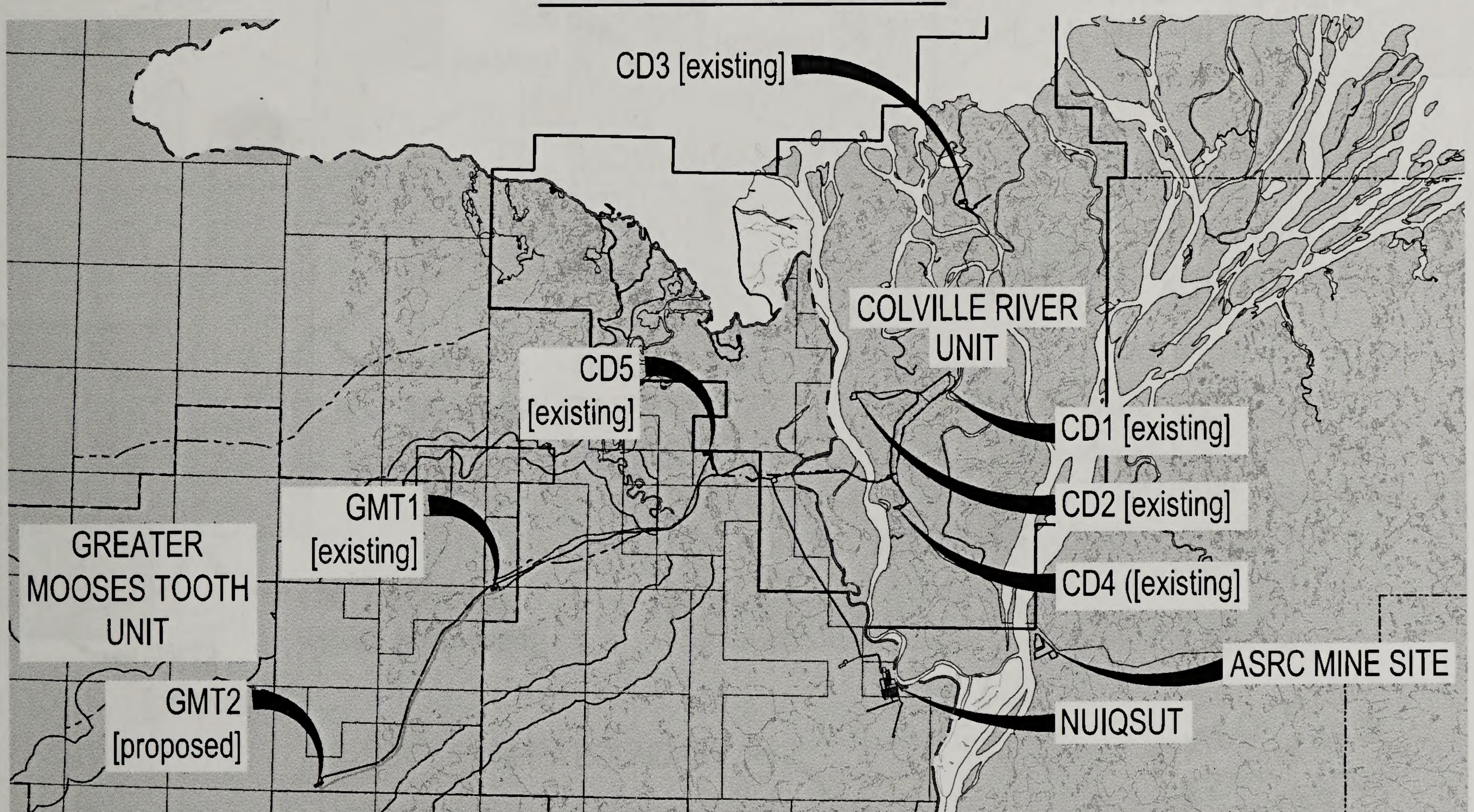
ALASKA VICINITY MAP



ALPINE SATELLITE DEVELOPMENT VICINITY MAP

SCALE IN MILES

3 0 3 6 9

P | N | D ENGINEERS, INC.

ConocoPhillips Alaska, Inc.

PURPOSE: CONSTRUCT A GRAVEL DRILLING PAD AND ROAD ACCESS FOR OILFIELD DEVELOPMENT DATUM: BPMSL, NAD83 ASP ZONE 4 ADJACENT PROPERTY OWNERS: 1. KUUKPIK VILLAGE CORP 2. BUREAU OF LAND MANAGEMENT 3. ARCTIC SLOPE REGIONAL CORP 4. STATE OF ALASKA DNR	REFERENCE: POA XXXX-XXX APPLICANT: CONOCOPHILLIPS ALASKA, INC (CPAI) LOCATION: T10N, R3E UMIAT MERIDIAN	PROPOSED: GMT2 ROAD, PAD & PIPELINE CONSTRUCTION IN: GREATER MOOSES TOOTH UNIT NEAR/AT: ALPINE COUNTY: NORTH SLOPE BOROUGH STATE: ALASKA SHEET **1** of **33** 05/11/17

KUUKPIK VILLAGE CORPORATION
P.O. BOX 89187
NUIQSUT, AK 99789
(907) 480-6220
ATTN: JOE NUKAPIGAK

BUREAU OF LAND MANAGEMENT
1150 UNIVERSITY AVENUE
FAIRBANKS, AK 99709
ATTN: STACIE MCINTOSH

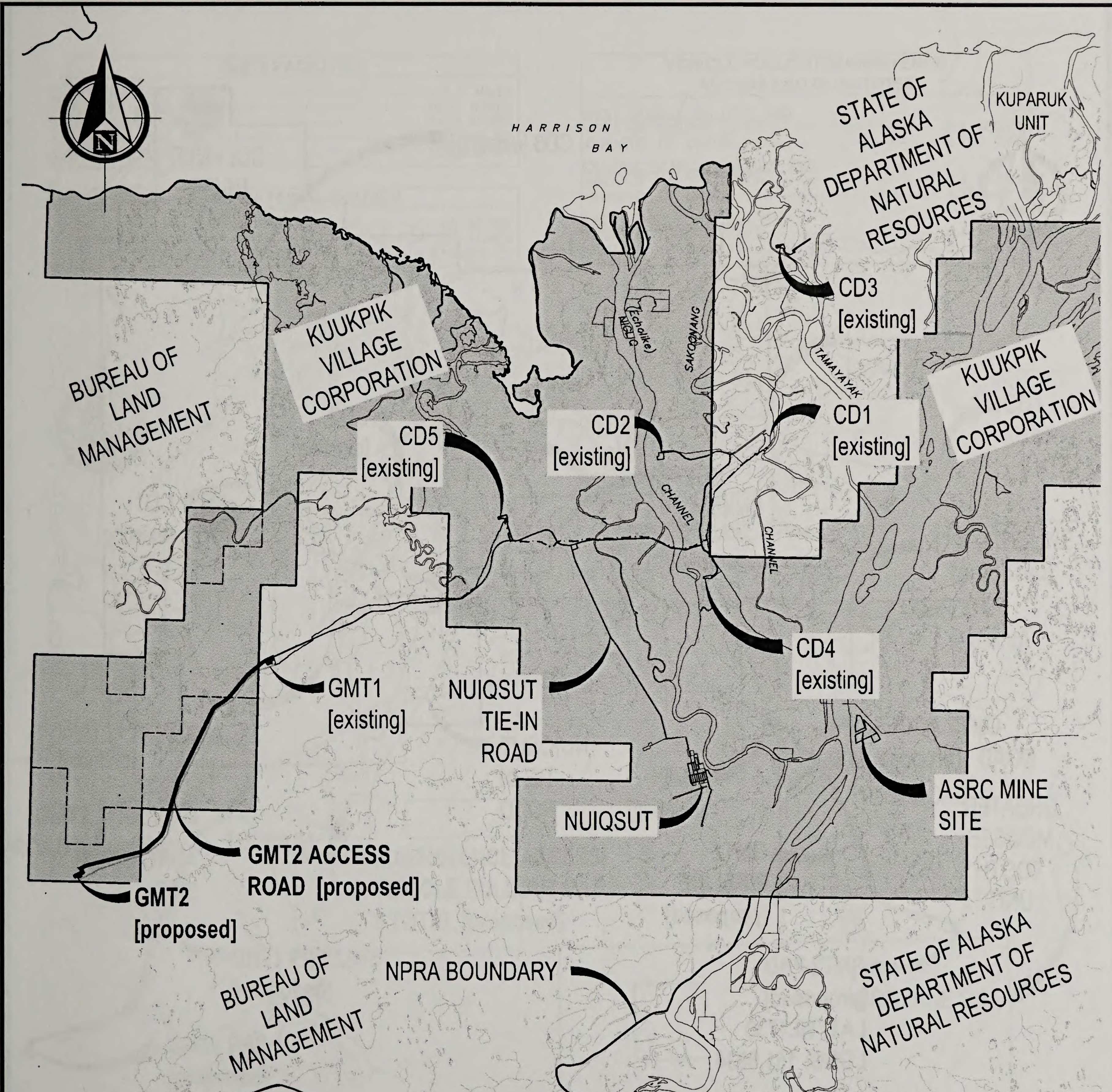
ARCTIC SLOPE REGIONAL CORPORATION
P.O. BOX 129
BARROW, AK 99723
ATTN: REX A. ROCK SR.

STATE OF ALASKA DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINING, LAND & WATER
3700 AIRPORT WAY
FAIRBANKS, AK 99709
ATTN: JEANNE PROULX

GMT2 ADJACENT LAND OWNERS

PND ENGINEERS, INC.
ConocoPhillips Alaska, Inc.

REFERENCE: POA XXXX-XX
APPLICANT: CPAI
PROPOSED: GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT: ALASKA
SHEET **2** of **33** 05/11/17



GMT2 ADJACENT LAND OWNERS MAP

SCALE IN MILES

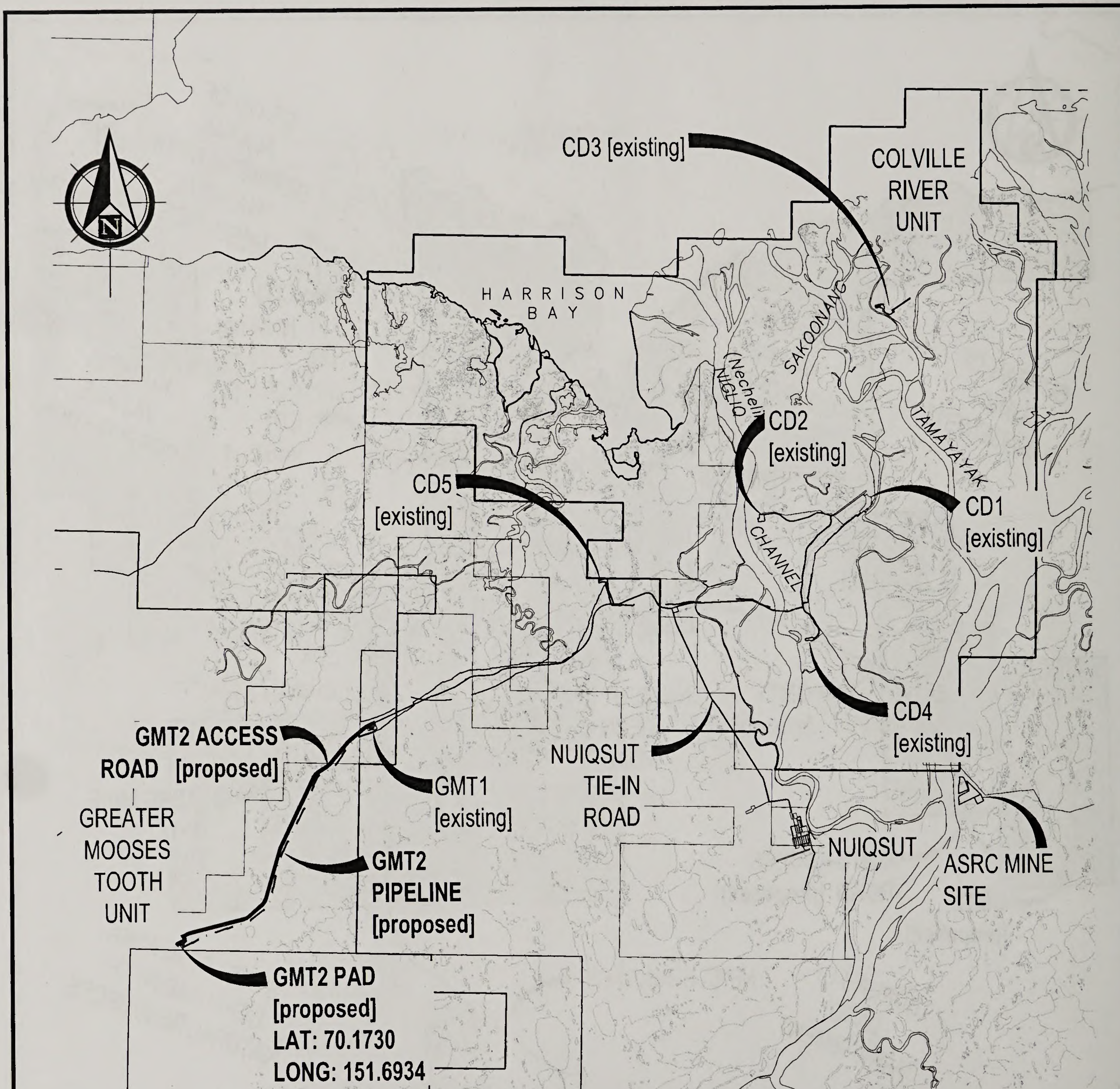
2 0 2 4 6

PND ENGINEERS, INC.

ConocoPhillips Alaska, Inc.

THIS MAP PROJECTION IS BASED UPON ALASKA STATE PLANE, NAD 83. THIS MAP IS BASED ON DATA PROVIDED BY THE U.S. GEOLOGICAL SURVEY, THE ALASKA DEPARTMENT OF NATURAL RESOURCES, AND CONOCO PHILLIPS ALASKA, INC.

REFERENCE:	POA XXXX-XX
APPLICANT:	CPAI
PROPOSED:	GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT:	ALASKA
SHEET **3** of **33**	05/11/17



ALPINE SATELLITE DEVELOPMENT LOCATION MAP

PND ENGINEERS, INC.

ConocoPhillips Alaska, Inc.

SCALE IN MILES

2 0 2 4 6

- GREATER MOOSES TOOTH UNIT BOUNDARY
- COLVILLE RIVER OIL & GAS UNIT BOUNDARY
- NUIQSUT MUNICIPAL BOUNDARY
- FISH CREEK 3 MILE BUFFER
- TIŊMIAQSIUĠVIK (UBLUTUOCH) RIVER 1/2 MILE BUFFER

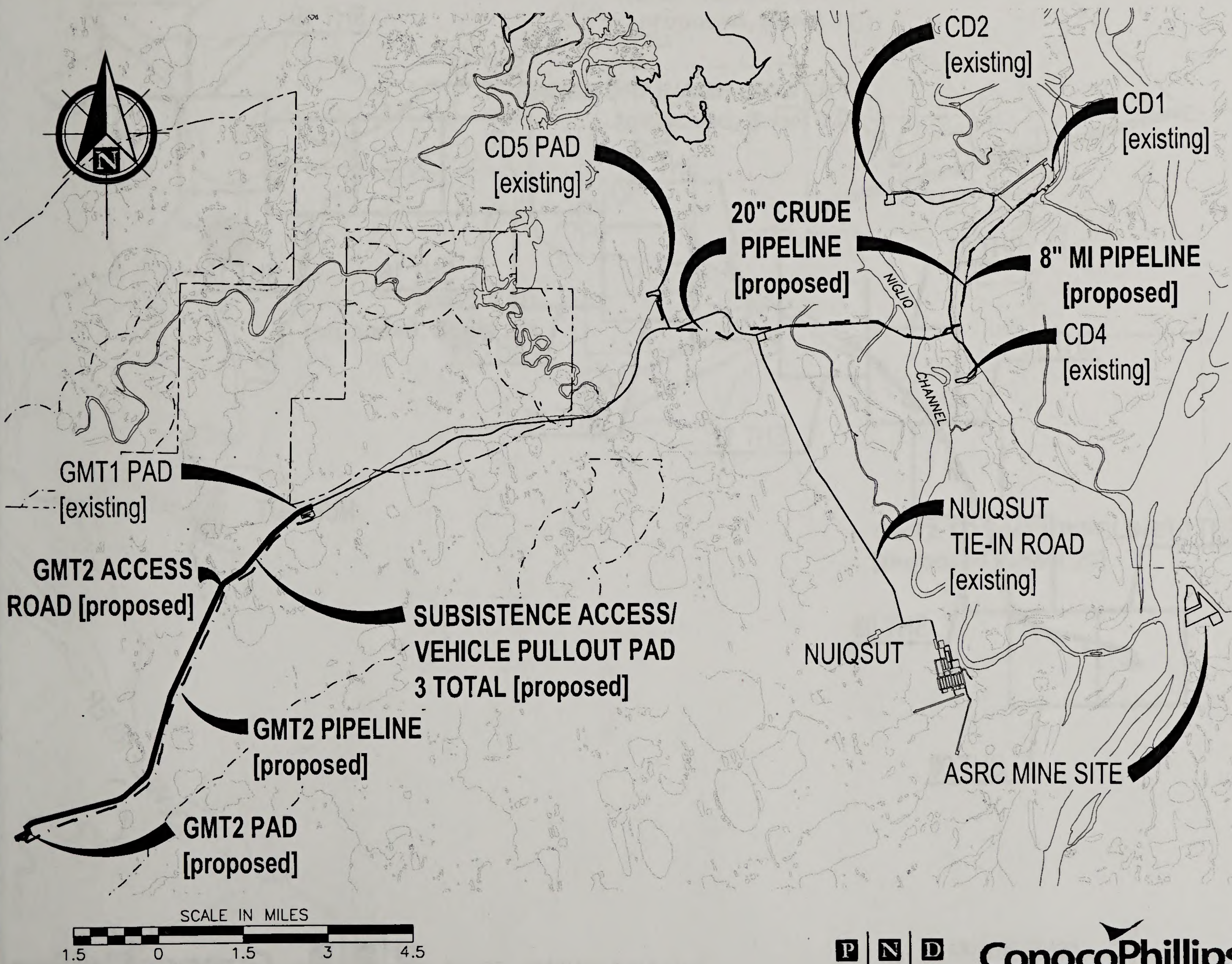
THIS MAP PROJECTION IS BASED UPON ALASKA STATE PLANE, NAD 83. THIS MAP IS BASED ON DATA PROVIDED BY THE U.S. GEOLOGICAL SURVEY, THE ALASKA DEPARTMENT OF NATURAL RESOURCES, AND CONOCO PHILLIPS ALASKA, INC.

REFERENCE:	POA XXXX-XX
APPLICANT:	CPAI
PROPOSED:	GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT:	ALASKA
SHEET	4 of 33 05/11/17

GMT2 FACILITIES	
ACCESS ROAD LENGTH	8.2 MILES
ACCESS ROAD FOOTPRINT	62.8 ACRES
PAD FOOTPRINT	14.0 ACRES
ACCESS ROAD FILL QUANTITY	510,000 CY
PAD FILL QUANTITY	152,000 CY

ASRC MATERIAL SOURCE	
GMT2 MATERIAL SOURCE PIT FOOTPRINT	23 ACRES
PERMIT AREA	23 ACRES
GRAVEL REQUIREMENT FOR GMT2	671,300 CY

VEHICLE PULLOUT/SUBSISTENCE ACCESS PAD QUANTITIES	
WEST VEHICLE PULLOUT PAD	
AREA OF TUNDRA COVER	0.4 ACRES
QUANTITY OF GRAVEL	3,100 CY
CENTRAL VEHICLE PULLOUT PAD	
AREA OF TUNDRA COVER	0.4 ACRES
QUANTITY OF GRAVEL	3,100 CY
EAST VEHICLE PULLOUT PAD	
AREA OF TUNDRA COVER	0.4 ACRES
QUANTITY OF GRAVEL	3,100 CY



P | N | D ENGINEERS, INC.

ConocoPhillips Alaska, Inc.

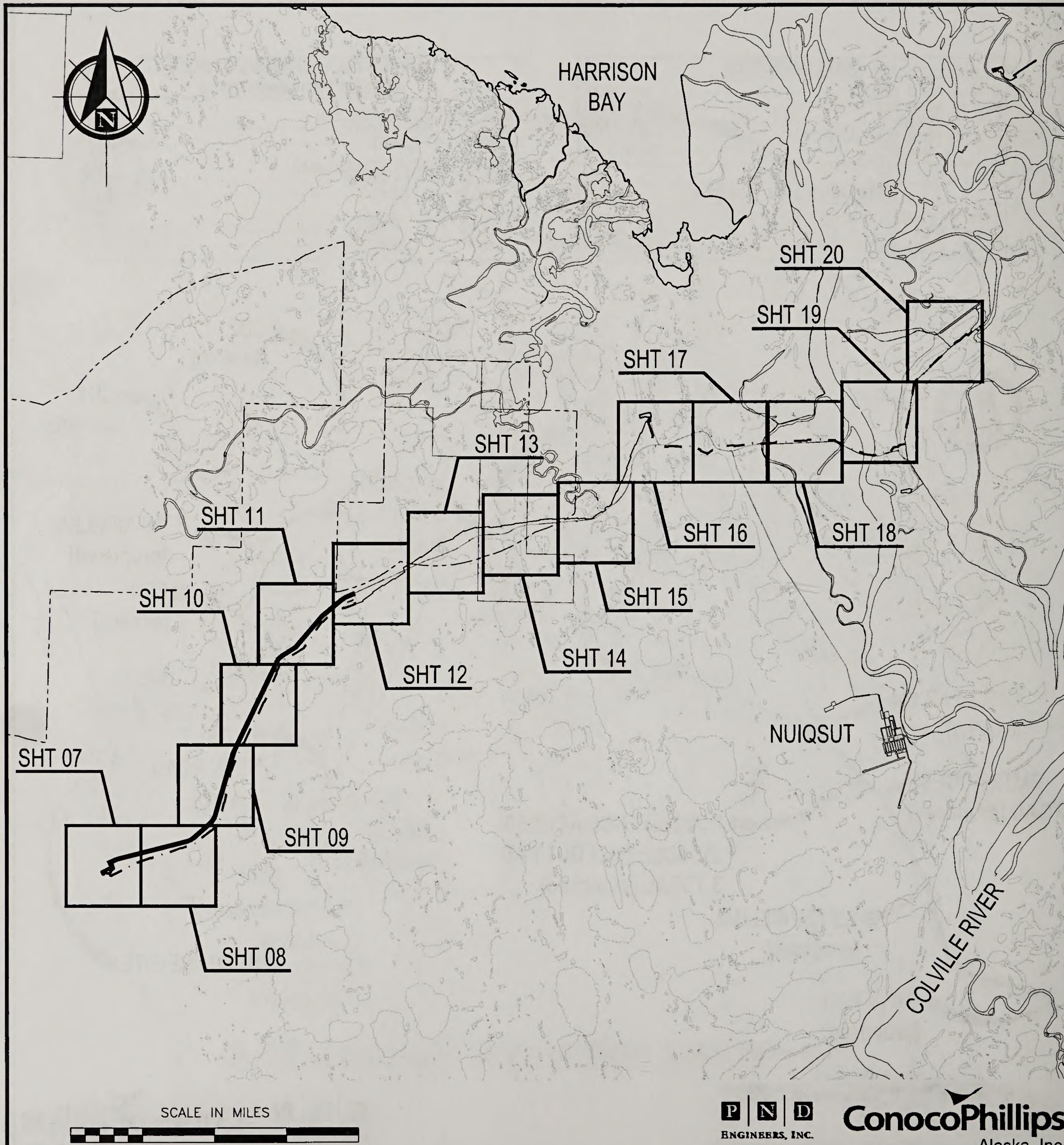
REFERENCE:	POA XXXX-XX
APPLICANT:	CPAI
PROPOSED:	GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT:	ALASKA
SHEET	**5** of **33** 05/11/17

——-——-— FISH CREEK 3 MILE BUFFER

-—-—-—-— TIŊMIAQSIUĠVIK(UBLUTUOCH) RIVER 1/2 MILE BUFFER

THIS MAP PROJECTION IS BASED UPON ALASKA STATE PLANE, NAD 83. THIS MAP IS BASED ON DATA PROVIDED BY THE U.S. GEOLOGICAL SURVEY, THE ALASKA DEPARTMENT OF NATURAL RESOURCES, AND CONOCO PHILLIPS ALASKA, INC.

GMT2 PROPOSED SATELLITE FACILITY OVERVIEW

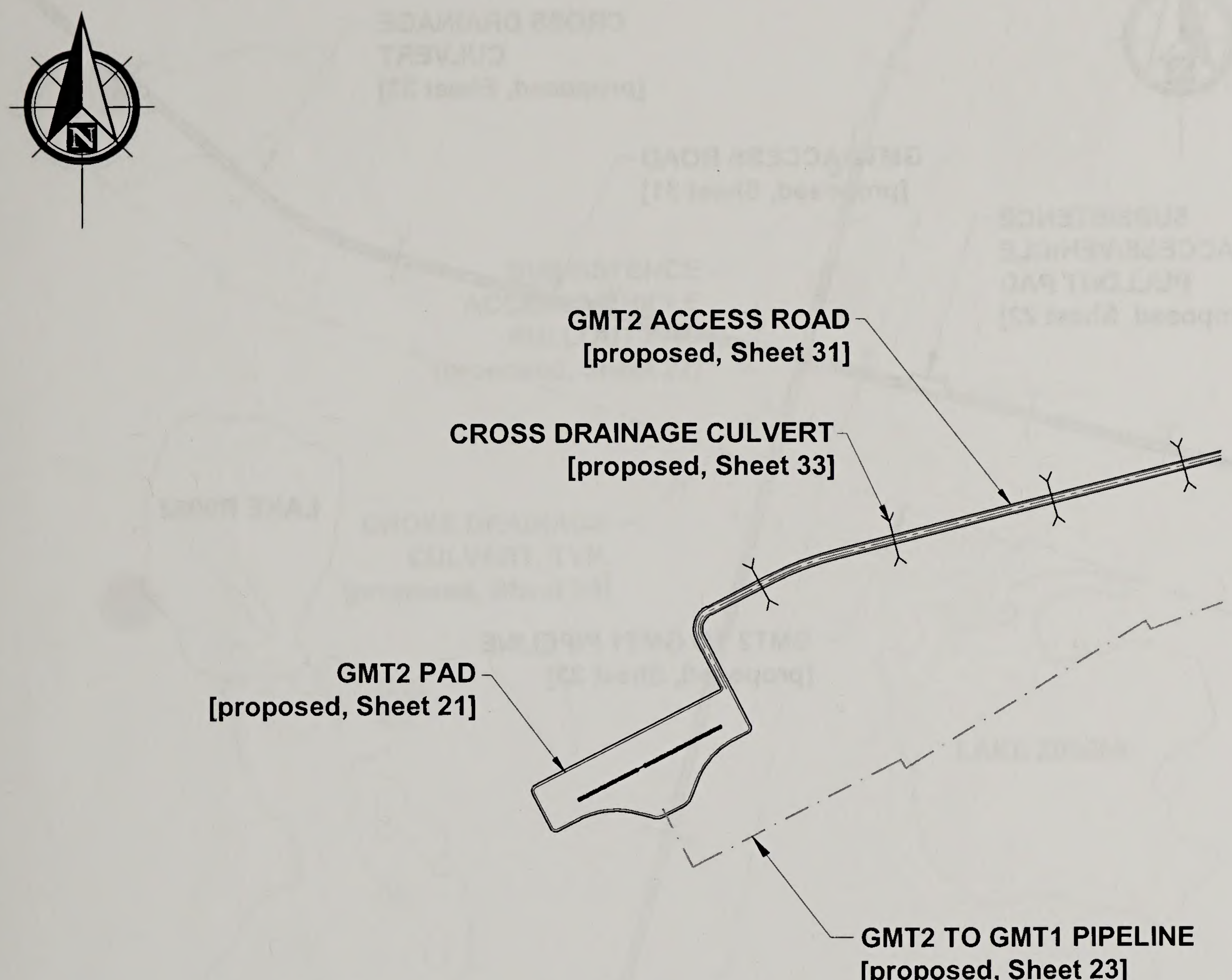


P N D ENGINEERS, INC.

ConocoPhillips Alaska, Inc.

REFERENCE: POA XXXX-XX
APPLICANT: CPAI
PROPOSED: GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT: ALASKA
SHEET **6** of **33** 05/11/17

GMT2 PROPOSED ACCESS ROAD AND PIPELINE ROUTE KEY MAP



NOTE: 24" MINIMUM CULVERT SIZE FOR CROSS DRAINAGE. CULVERT LOCATIONS, SIZES, AND QUANTITIES TO BE DETERMINED DURING A SUMMER FIELD SURVEY PRIOR TO CONSTRUCTION.

SCALE IN FEET

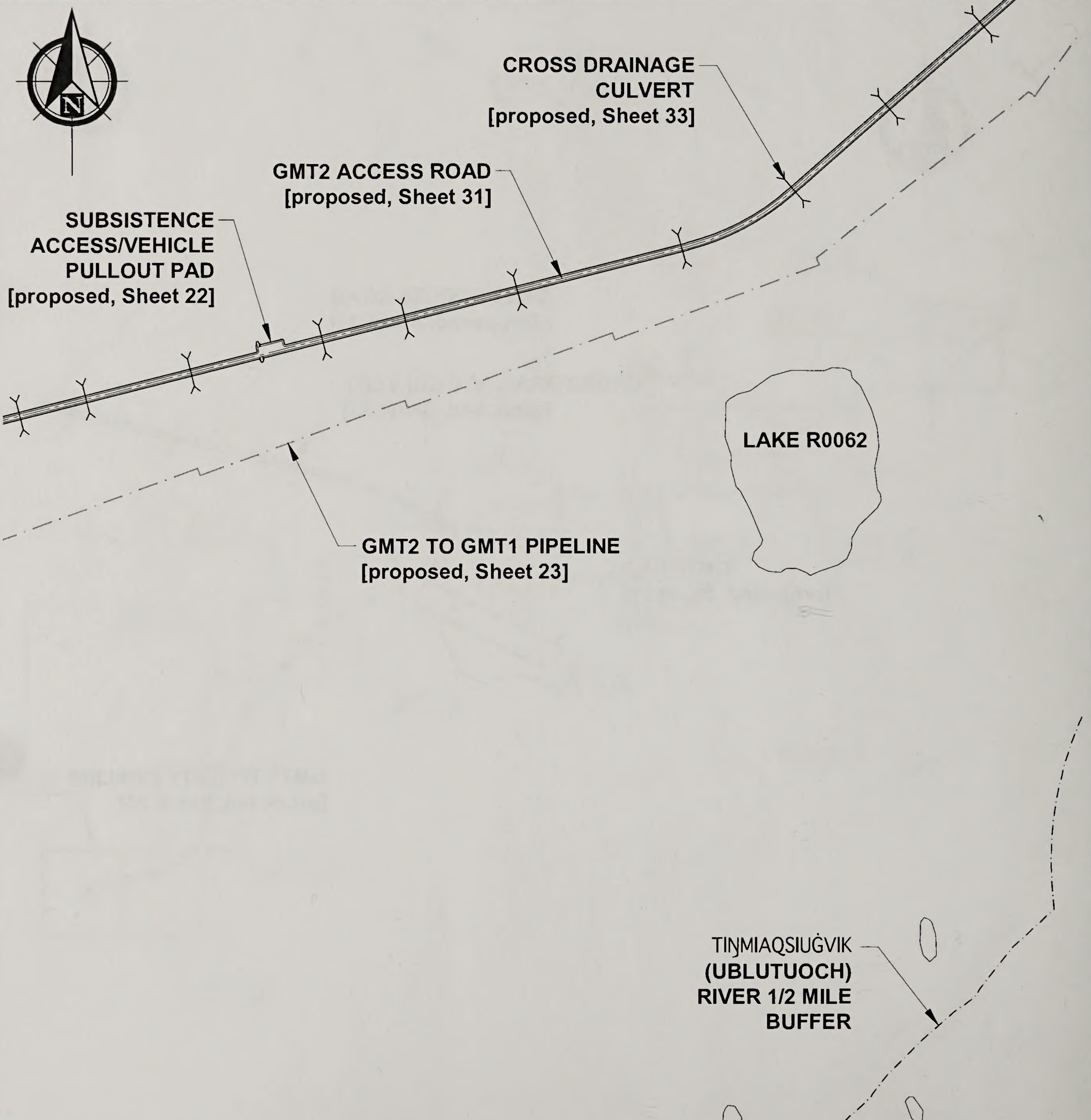
600 0 600 1200 1800 FT

PROPOSED GMT2
ACCESS ROAD AND PIPELINE
ROUTE KEY MAP 1 of 14

PND ENGINEERS, INC.

ConocoPhillips Alaska, Inc.

REFERENCE:	POA XXXX-XX
APPLICANT:	CPAI
PROPOSED:	GMT2 ROAD, PAD; & PIPELINE CONSTRUCTION
AT:	ALASKA
SHEET	7 of 33 05/11/17



PND ENGINEERS, INC.

ConocoPhillips Alaska, Inc.

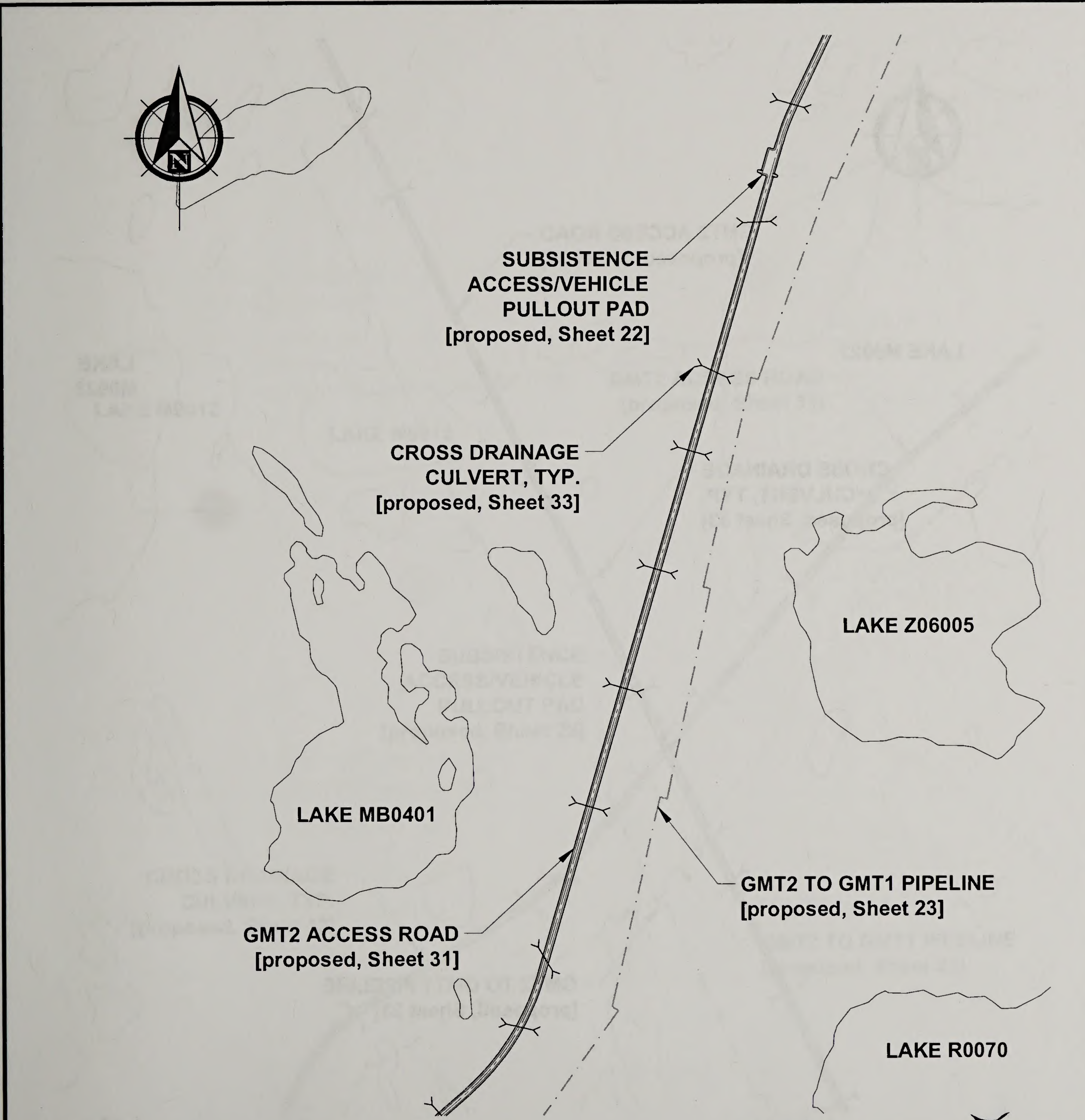
NOTE: 24" MINIMUM CULVERT SIZE FOR CROSS DRAINAGE. CULVERT LOCATIONS, SIZES, AND QUANTITIES TO BE DETERMINED DURING A SUMMER FIELD SURVEY PRIOR TO CONSTRUCTION.

SCALE IN FEET

600 0 600 1200 1800 FT

PROPOSED GMT2
ACCESS ROAD AND PIPELINE
ROUTE KEY MAP 2 of 14

REFERENCE:	POA XXXX-XX
APPLICANT:	CPAI
PROPOSED:	GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT:	ALASKA
SHEET	**8** of **33** 05/11/17



PND ENGINEERS, INC.

ConocoPhillips Alaska, Inc.

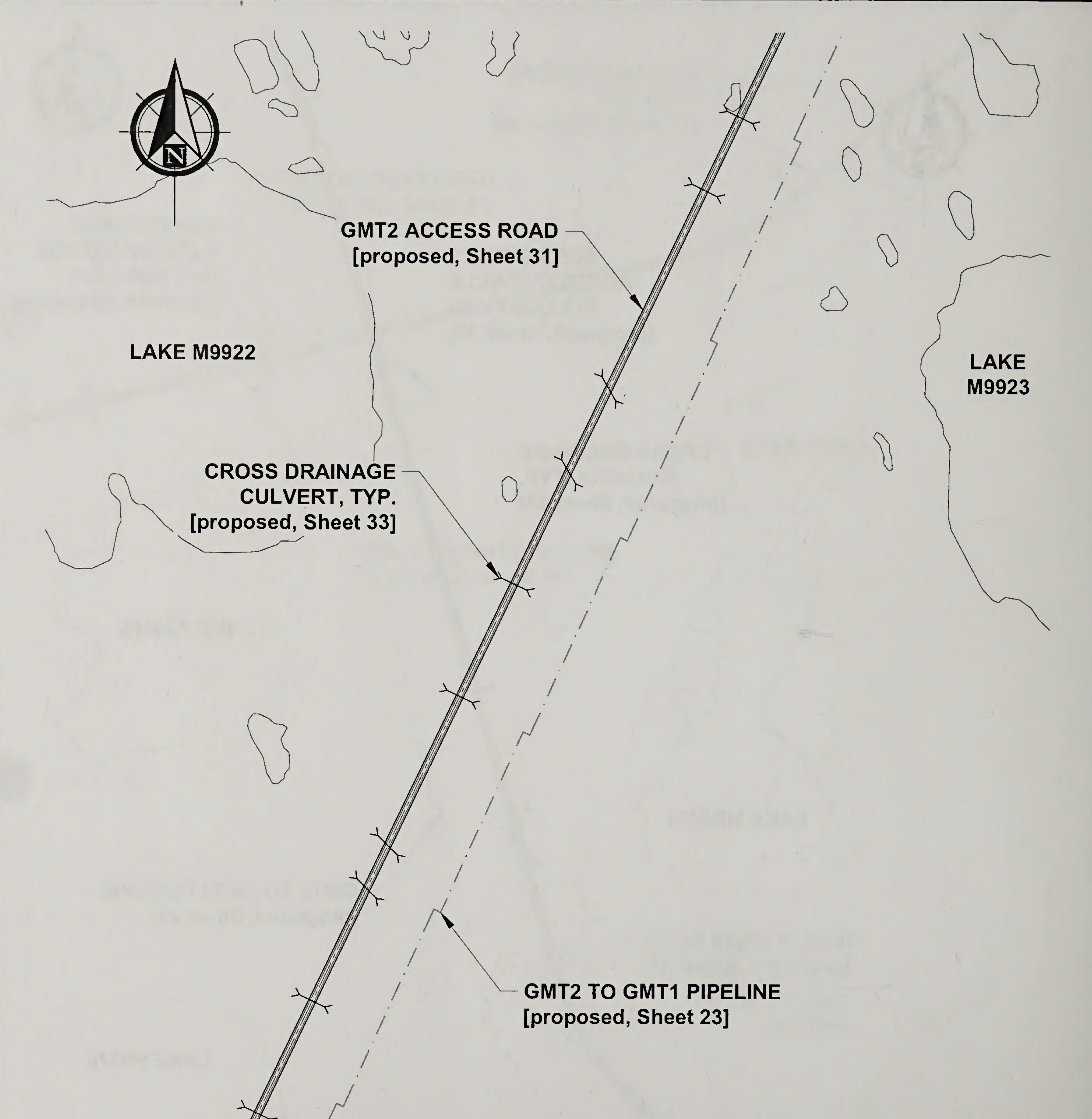
NOTE: 24" MINIMUM CULVERT SIZE FOR CROSS DRAINAGE. CULVERT LOCATIONS, SIZES, AND QUANTITIES TO BE DETERMINED DURING A SUMMER FIELD SURVEY PRIOR TO CONSTRUCTION.

SCALE IN FEET

600 0 600 1200 1800 FT

PROPOSED GMT2 ACCESS ROAD AND PIPELINE ROUTE KEY MAP 3 of 14

REFERENCE:	POA XXXX–XX
APPLICANT:	CPAI
PROPOSED:	GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT:	ALASKA
SHEET	**9** of **33** 05/11/17



NOTE: 24" MINIMUM CULVERT SIZE FOR CROSS DRAINAGE. CULVERT LOCATIONS, SIZES, AND QUANTITIES TO BE DETERMINED DURING A SUMMER FIELD SURVEY PRIOR TO CONSTRUCTION.

SCALE IN FEET

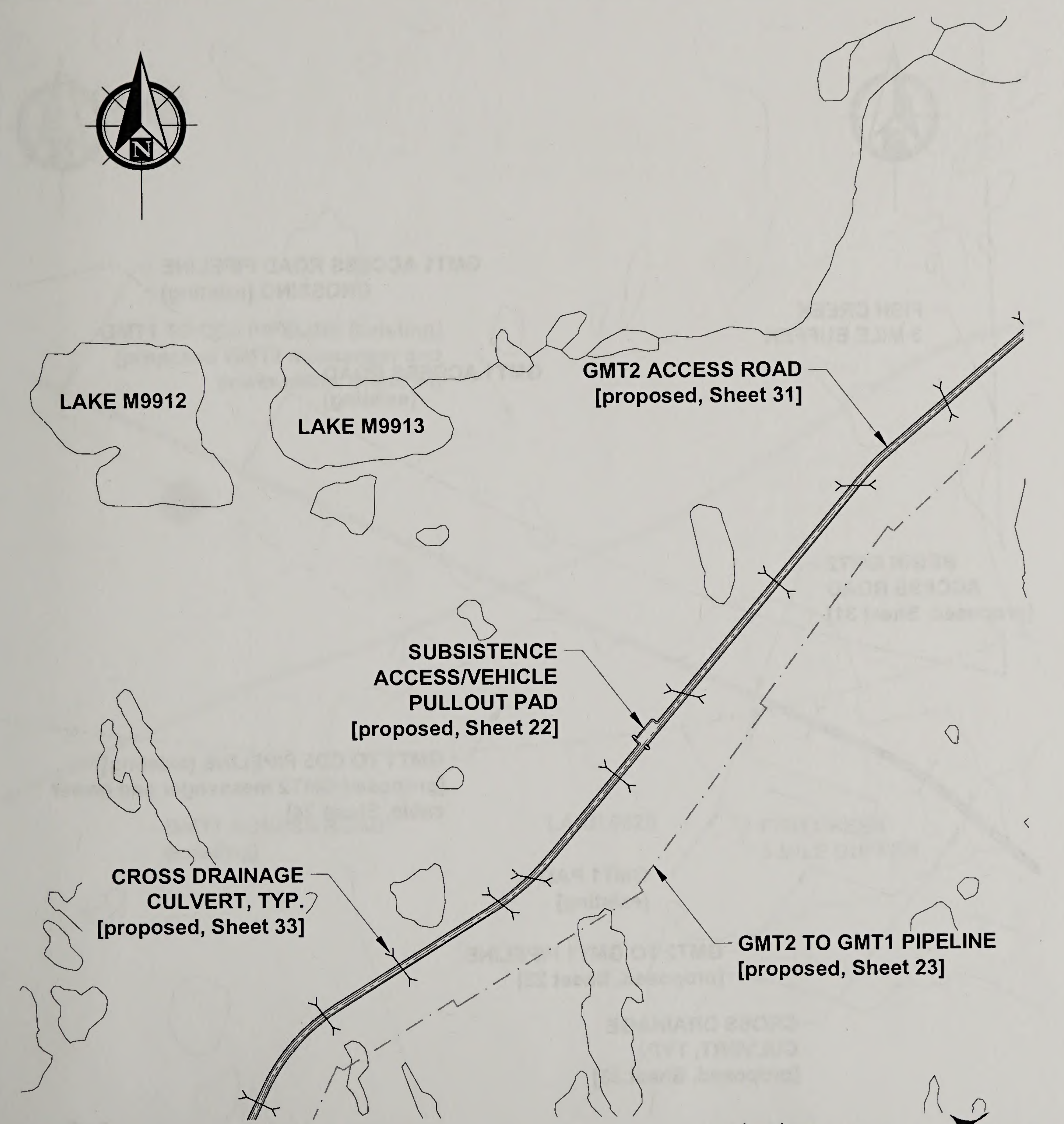
600 0 600 1200 1800 FT

PROPOSED GMT2
ACCESS ROAD AND PIPELINE
ROUTE KEY MAP 4 of 14

P | N | D
ENGINEERS, INC.

ConocoPhillips
Alaska, Inc.

REFERENCE:	POA XXXX-XX
APPLICANT:	CPAI
PROPOSED:	GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT:	ALASKA
SHEET **10** of **33**	05/11/17



NOTE: 24" MINIMUM CULVERT SIZE FOR CROSS DRAINAGE. CULVERT LOCATIONS, SIZES, AND QUANTITIES TO BE DETERMINED DURING A SUMMER FIELD SURVEY PRIOR TO CONSTRUCTION.

SCALE IN FEET

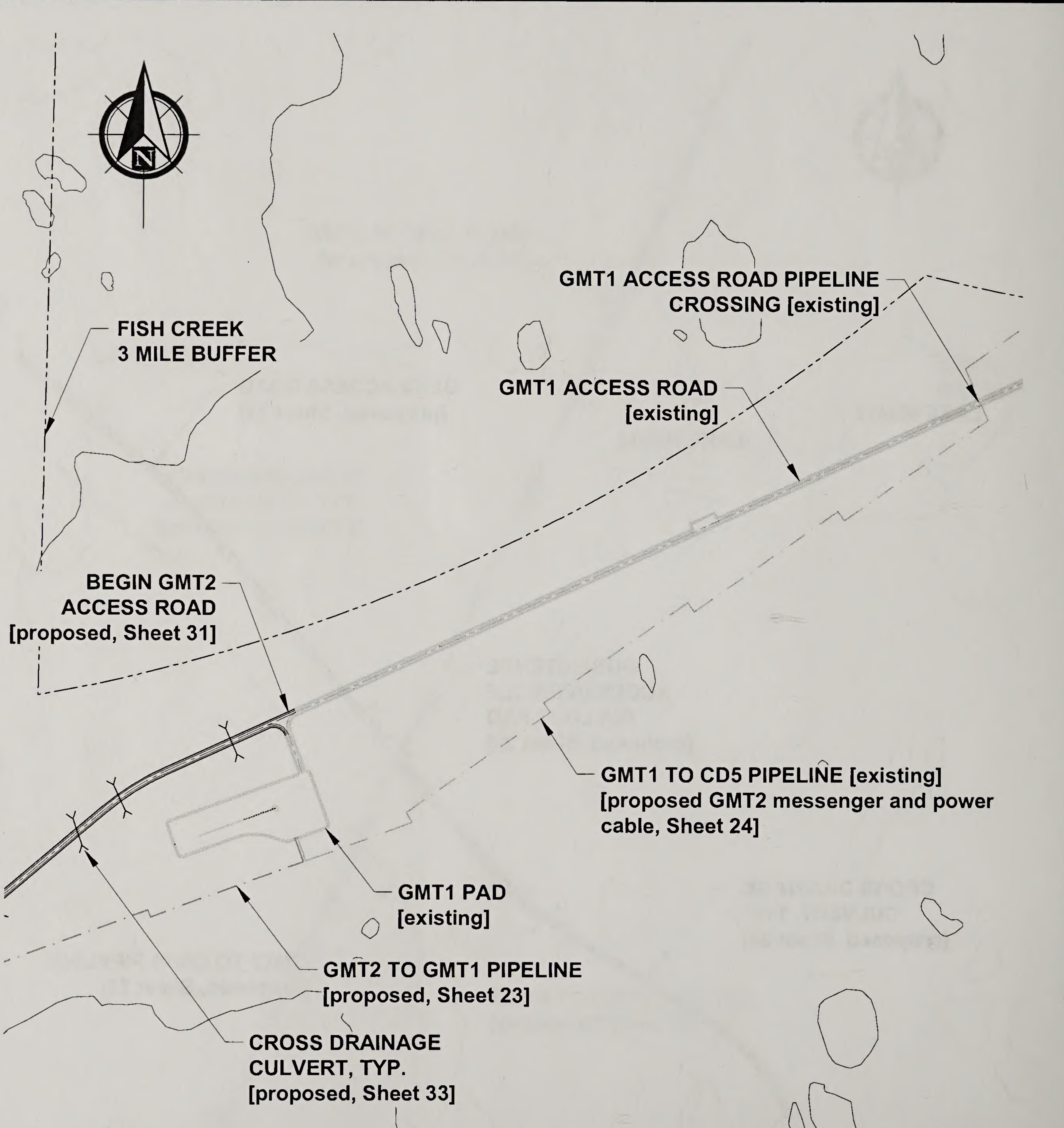
600 0 600 1200 1800 FT

PROPOSED GMT2
ACCESS ROAD AND PIPELINE
ROUTE KEY MAP 5 of 14

PND ENGINEERS, INC.

ConocoPhillips Alaska, Inc.

REFERENCE:	POA XXXX-XX
APPLICANT:	CPAI
PROPOSED:	GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT:	ALASKA
SHEET **11** of **33**	05/11/17



NOTE: 24" MINIMUM CULVERT SIZE FOR CROSS DRAINAGE. CULVERT LOCATIONS, SIZES, AND QUANTITIES TO BE DETERMINED DURING A SUMMER FIELD SURVEY PRIOR TO CONSTRUCTION.

SCALE IN FEET

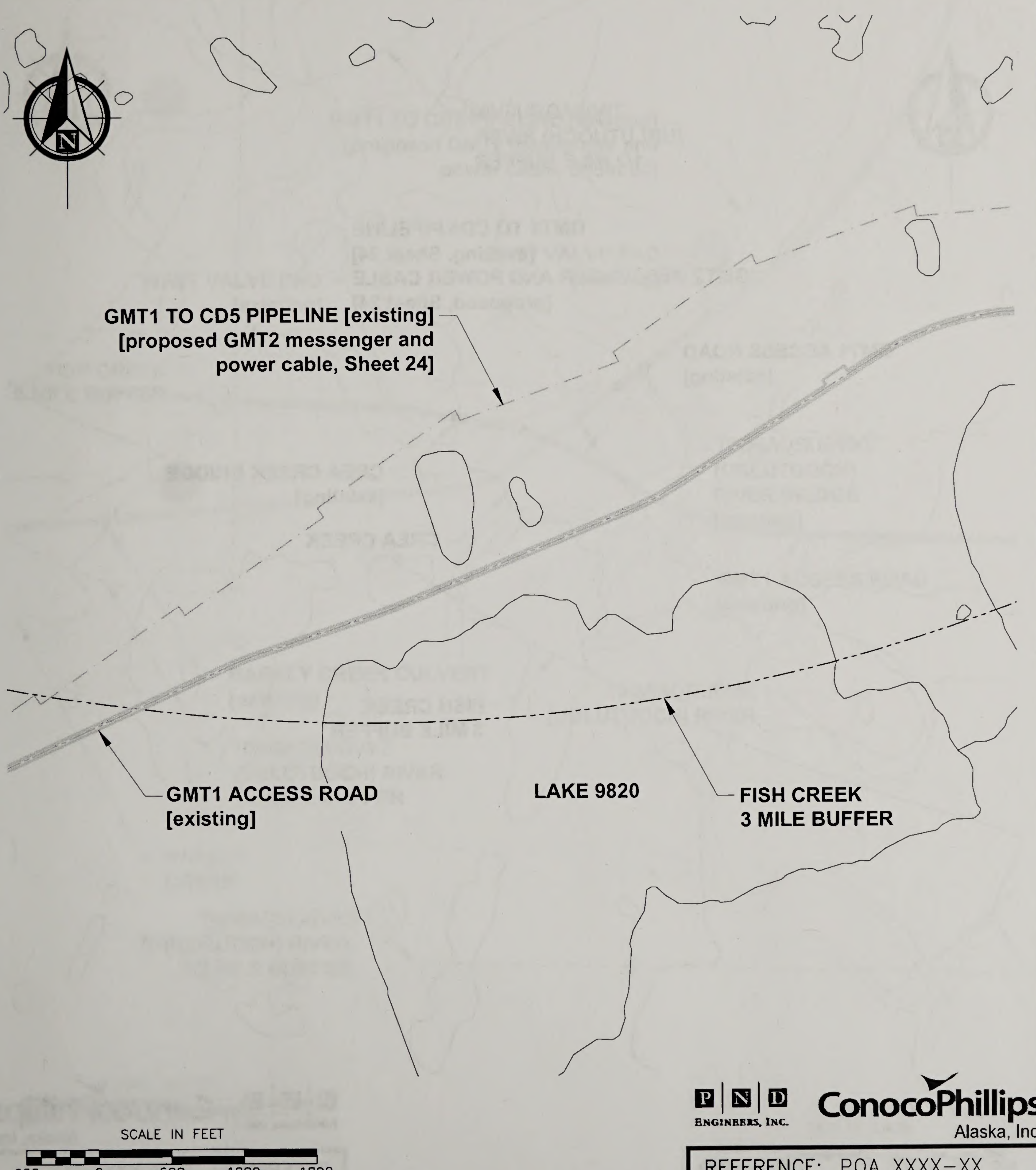
600 0 600 1200 1800 FT

PND ENGINEERS, INC.

ConocoPhillips Alaska, Inc.

PROPOSED GMT2
MESSENGER AND POWER CABLE
ROUTE KEY MAP 6 of 14

REFERENCE:	POA XXXX-XX
APPLICANT:	CPAI
PROPOSED:	GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT:	ALASKA
SHEET **12** of **33**	05/11/17

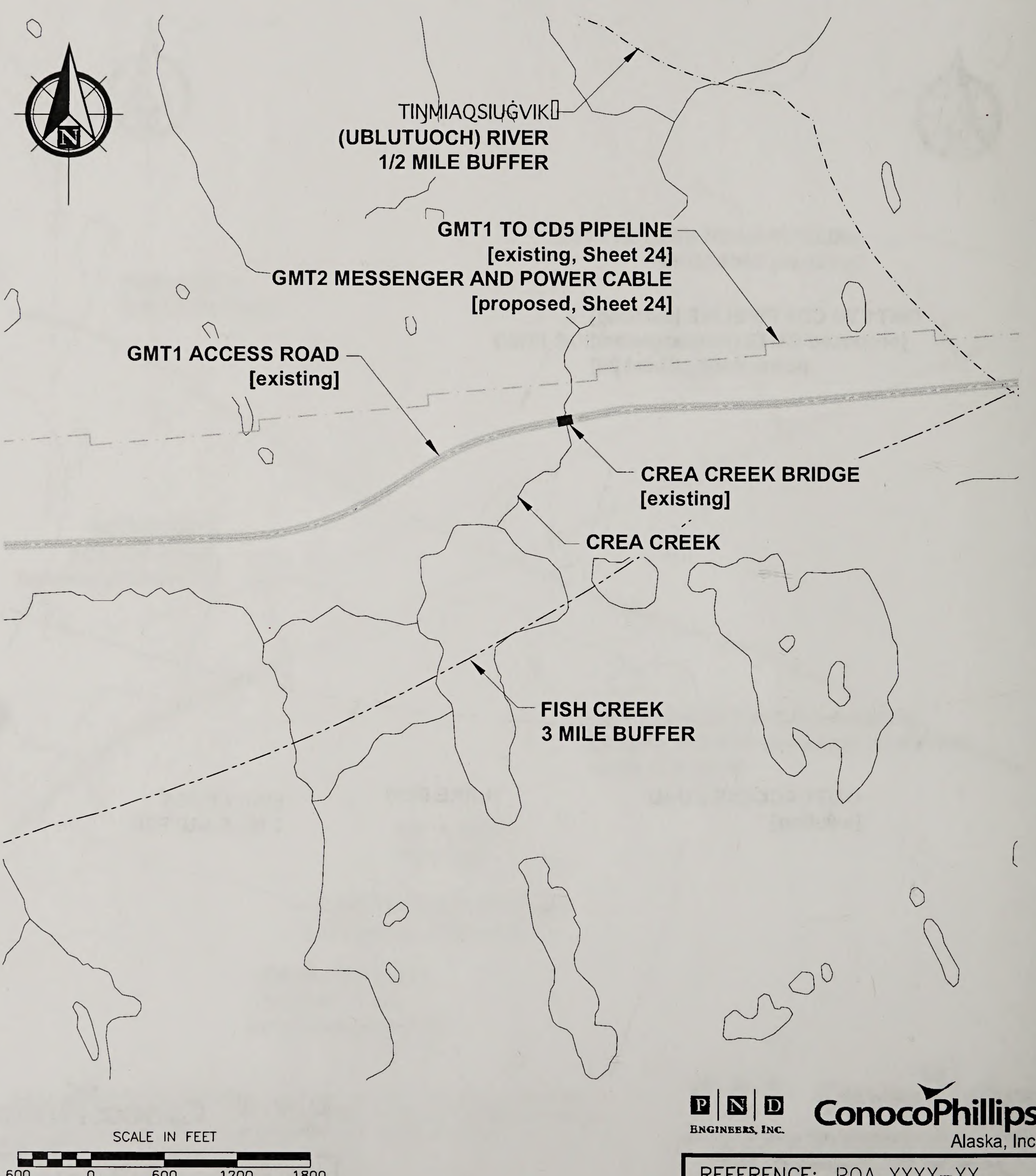


PND ENGINEERS, INC.

ConocoPhillips
Alaska, Inc.

REFERENCE:	POA XXXX-XX
APPLICANT:	CPAI
PROPOSED:	GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT:	ALASKA
SHEET **13** of **33**	05/11/17

PROPOSED GMT2
MESSENGER AND POWER CABLE
ROUTE KEY MAP 7 OF 14

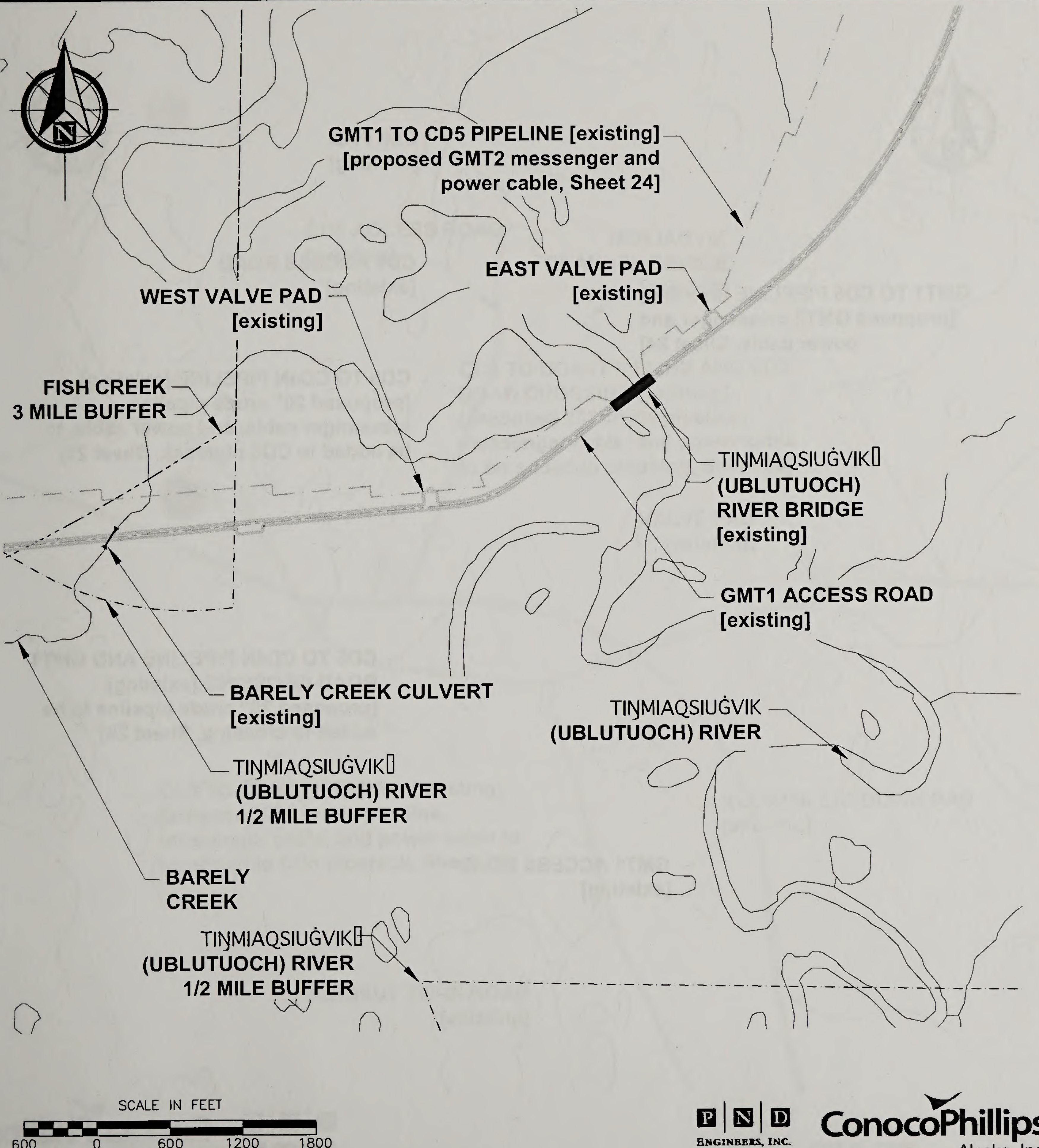


PND ENGINEERS, INC.

ConocoPhillips
Alaska, Inc.

PROPOSED GMT2
MESSENGER AND POWER CABLE
ROUTE KEY MAP 8 OF 14

REFERENCE:	POA XXXX-XX
APPLICANT:	CPAI
PROPOSED:	GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT:	ALASKA
SHEET **14** of **33**	05/11/17

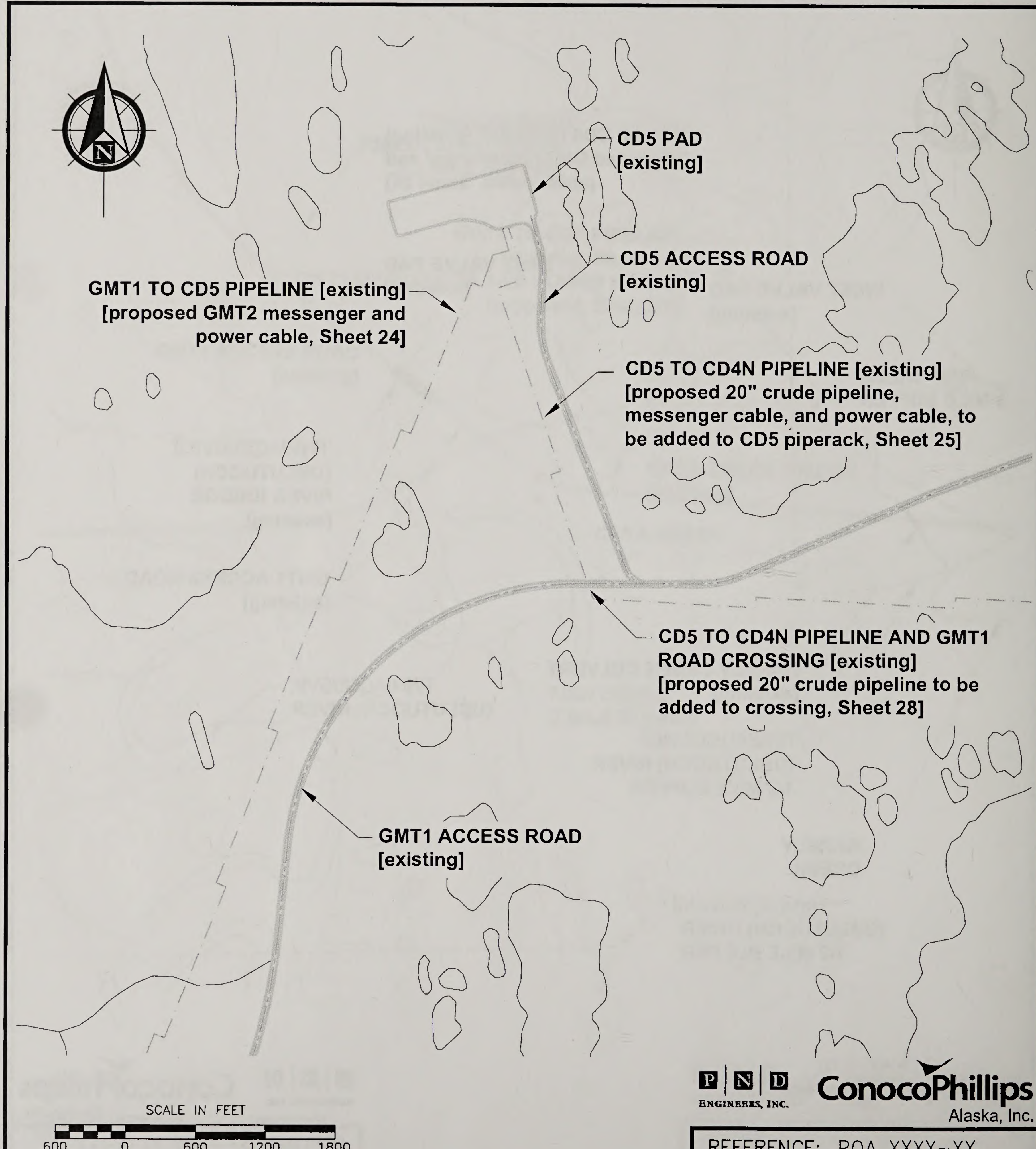


PND ENGINEERS, INC.

ConocoPhillips Alaska, Inc.

PROPOSED GMT2 MESSENGER AND POWER CABLE ROUTE KEY MAP 9 OF 14

REFERENCE:	POA XXXX–XX
APPLICANT:	CPAI
PROPOSED:	GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT:	ALASKA
SHEET **15** of **33**	05/11/17

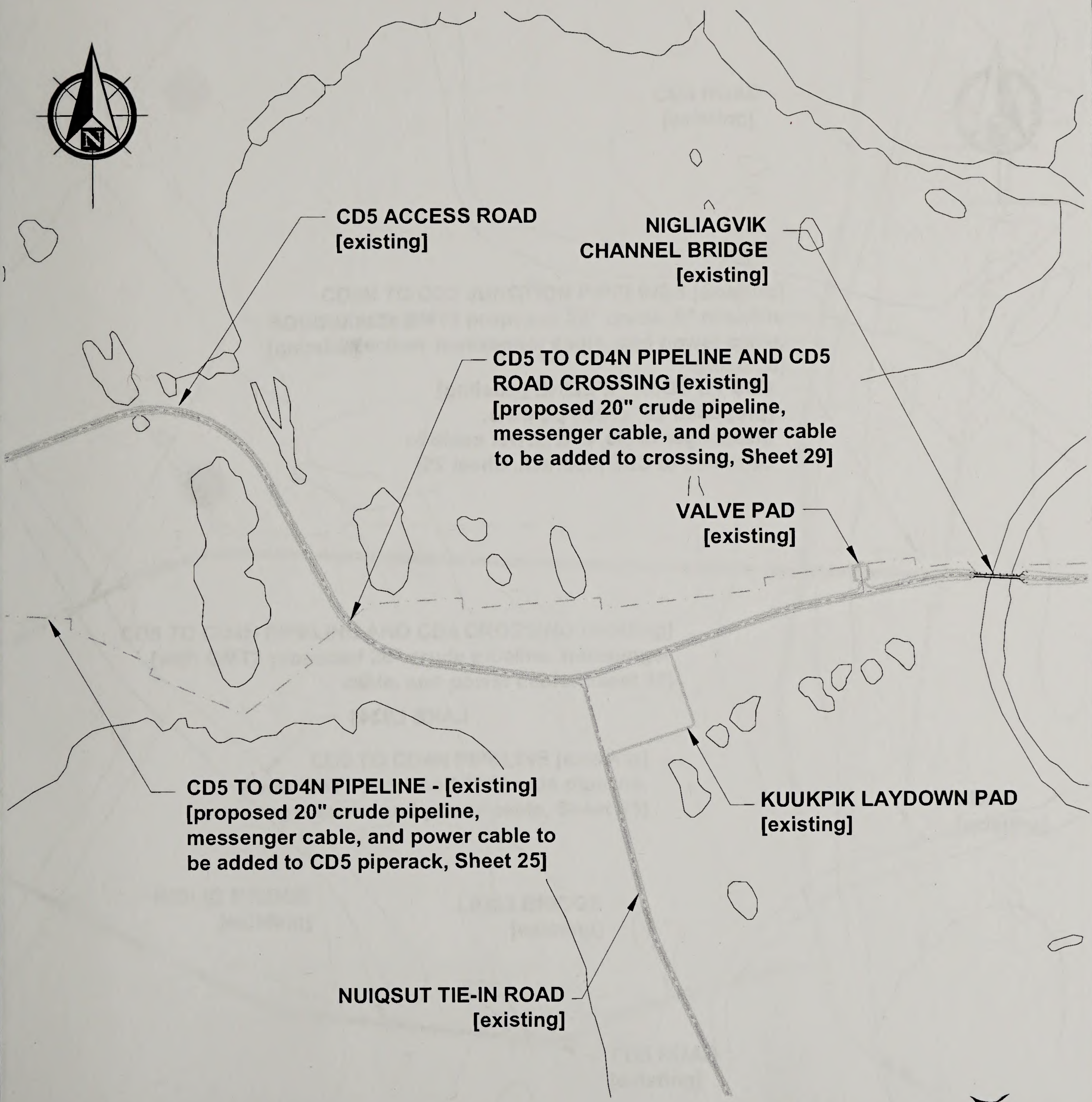


PND ENGINEERS, INC.

ConocoPhillips
Alaska, Inc.

PROPOSED GMT2
MESSENGER AND POWER CABLE
ROUTE KEY MAP 10 OF 14

REFERENCE: POA XXXX-XX
APPLICANT: CPAI
PROPOSED: GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT: ALASKA
SHEET **16** of **33** 05/11/17



PND ENGINEERS, INC.

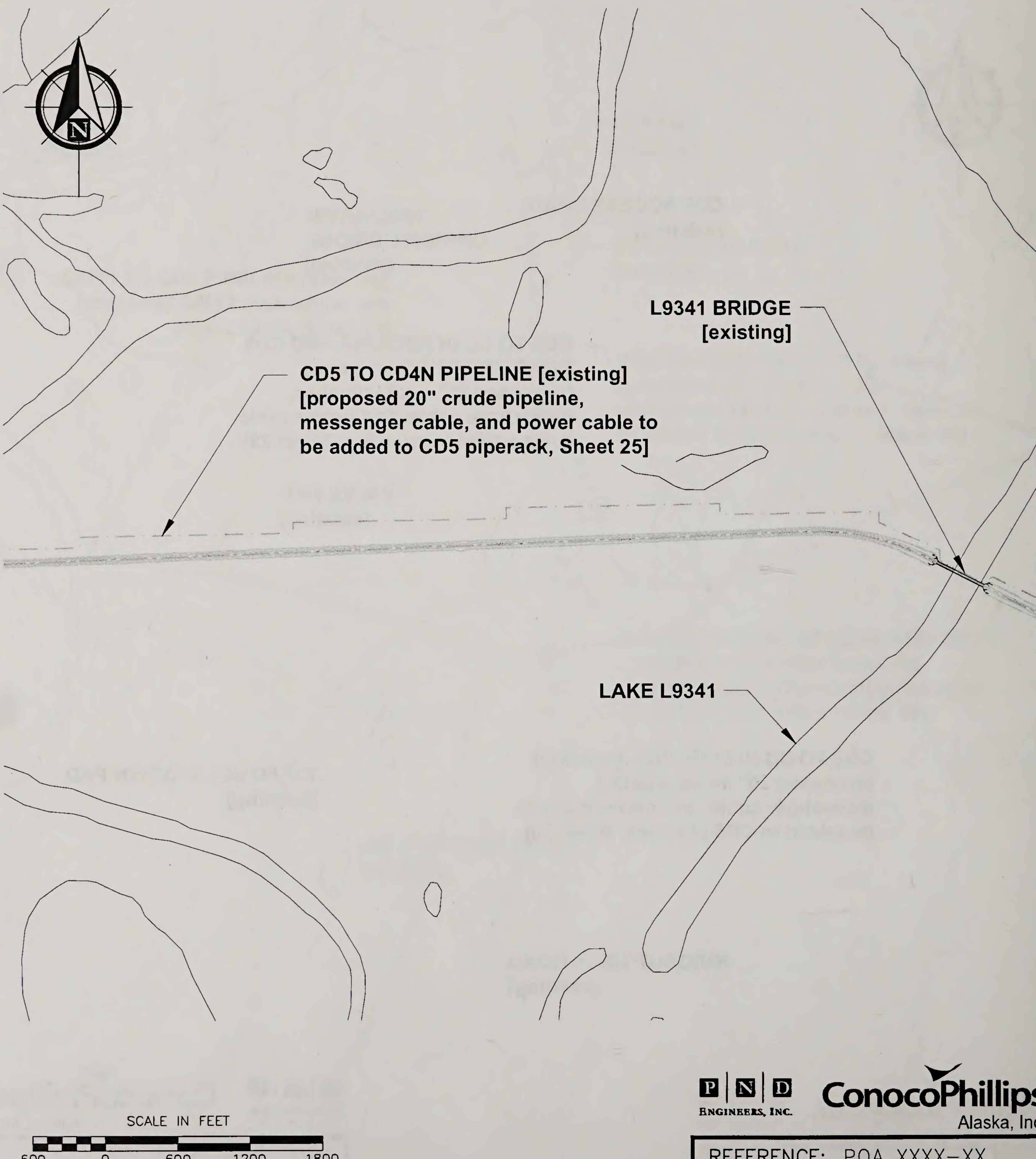
ConocoPhillips Alaska, Inc.

SCALE IN FEET

600 0 600 1200 1800

PROPOSED CRUDE PIPELINE, MESSENGER CABLE, AND POWER CABLE (CD5 TO CD4N PIPELINE) ROUTE KEY MAP 11 OF 14

REFERENCE:	POA XXXX-XX
APPLICANT:	CPAI
PROPOSED:	GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT:	ALASKA
SHEET 17 of 33	05/11/17



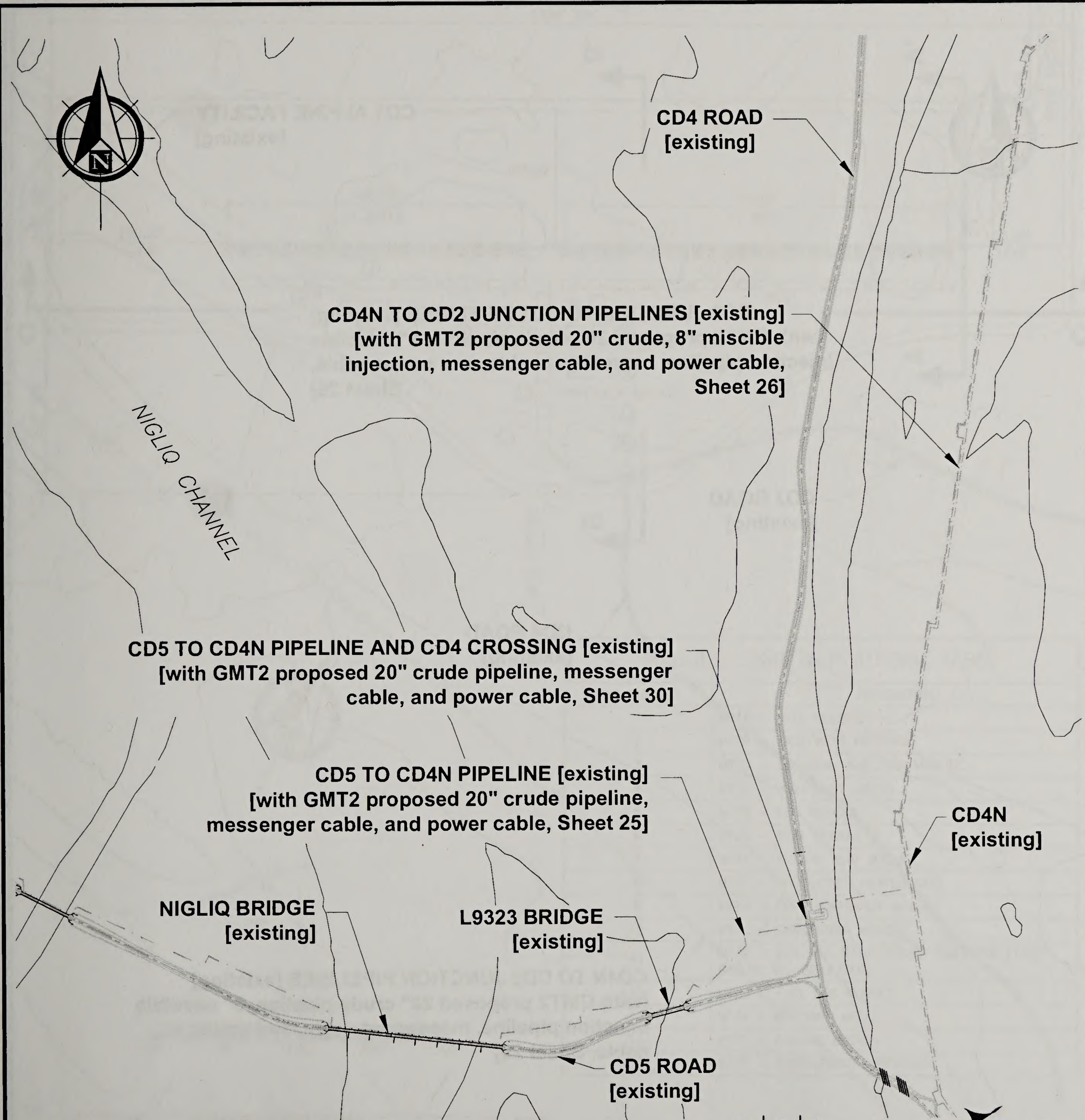
PND ENGINEERS, INC.

ConocoPhillips Alaska, Inc.

PROPOSED CRUDE PIPELINE, MESSENGER CABLE, AND POWER CABLE (CD5 TO CD4N PIPELINE) ROUTE KEY MAP 12 OF 14

REFERENCE:	POA XXXX-XX
APPLICANT:	CPAI
PROPOSED:	GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT:	ALASKA

SHEET **18** of **33** 05/11/17



SCALE IN FEET

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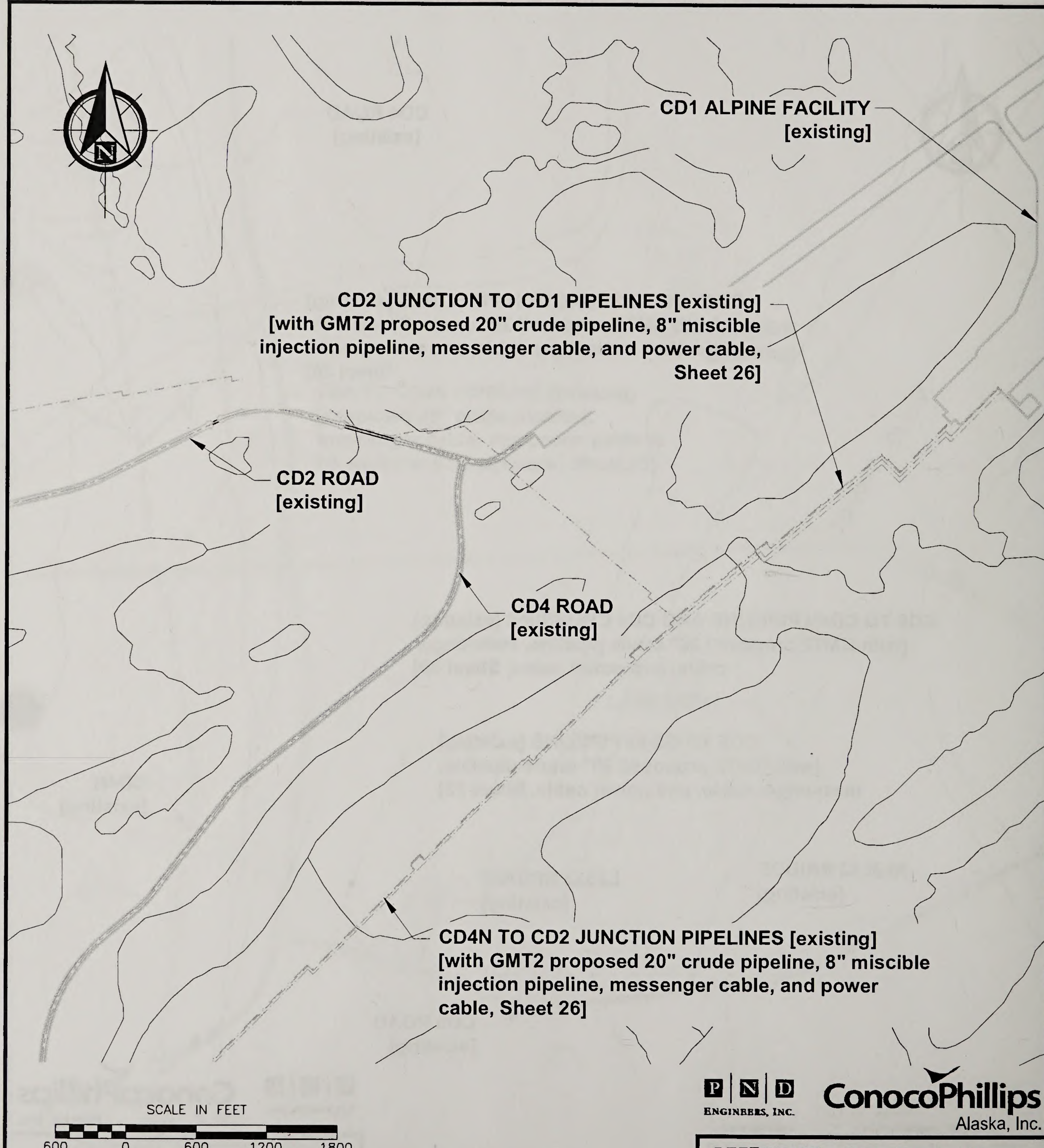
PND ENGINEERS, INC.

ConocoPhillips
Alaska, Inc.

PROPOSED GMT2 PIPELINE
(CD4N TO CD2 JUNCTION)
ROUTE KEY MAP 13 OF 14

REFERENCE:	POA XXXX-XX
APPLICANT:	CPAI
PROPOSED:	GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT:	ALASKA
SHEET **19** of **33**	05/11/17

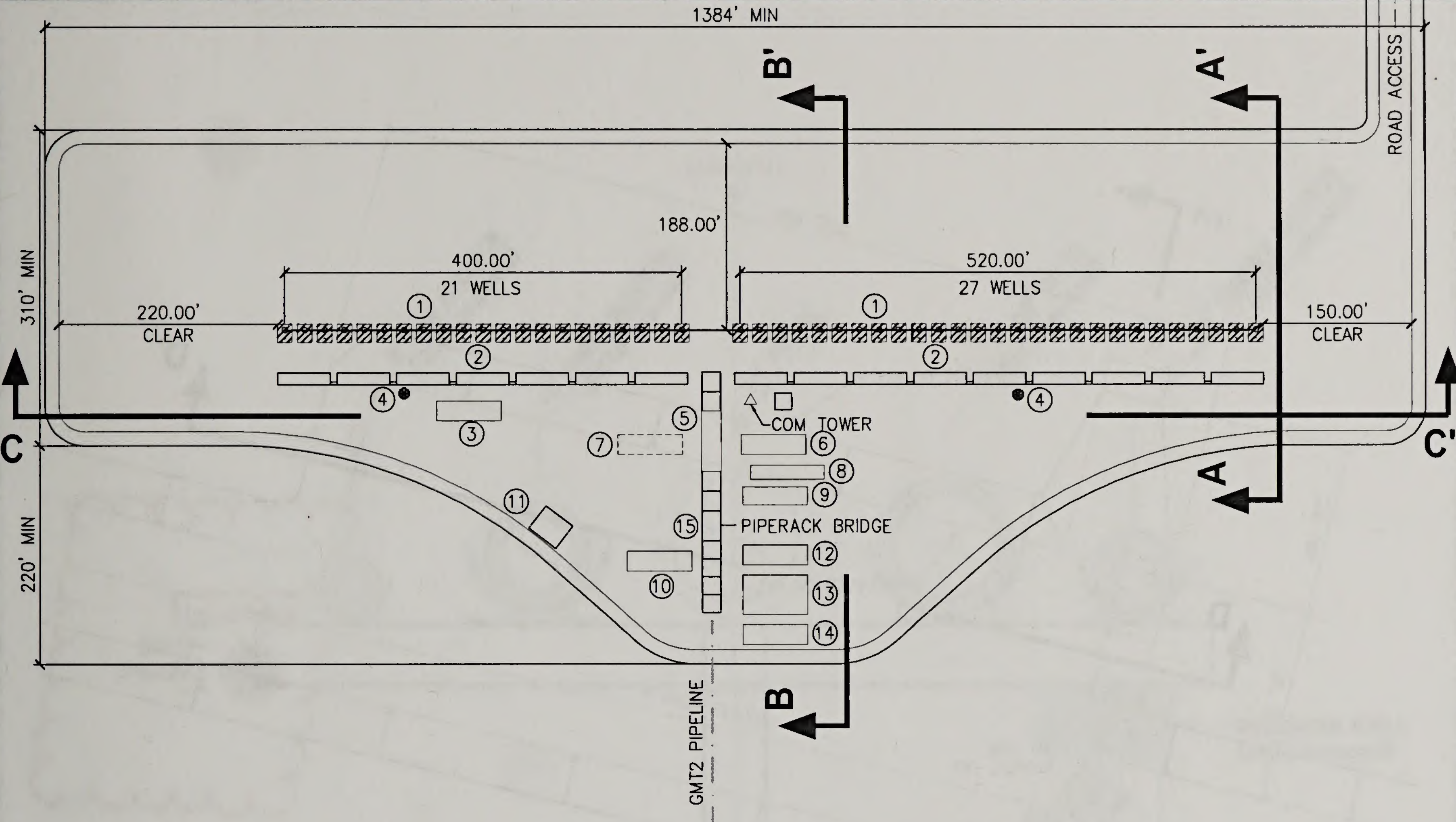


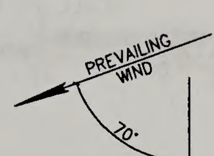
PND ENGINEERS, INC.

ConocoPhillips Alaska, Inc.

PROPOSED GMT2 PIPELINE
(CD2 JUNCTION TO CD1)
ROUTE KEY MAP 14 OF 14

REFERENCE:	POA XXXX-XX
APPLICANT:	CPAI
PROPOSED:	GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT:	ALASKA
SHEET **20** of **33**	05/11/17





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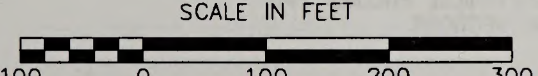


MODULE, SKID & PLATFORM TABLE	
TAG NUMBER	DESIGNATION
1	MT7A – WELL HOUSES
2	MT7P – EAST/WEST PIPERACK
3	MT7Q – CHEMICAL INJECTION MODULE
4	MT70 – HIGH MAST LIGHTS
5	MT7B – ESD MODULE
6	MT7D – REIM MODULE
7	MT7X – FUTURE REIM MODULE
8	MT7F – PRODUCTION HEATER SKID
9	MT7H – TEST SEPARATOR MODULE
10	MT7E – SWITCHGEAR MODULE
11	MT70 – 2/3 MVA TRANSFORMER PLATFORM (1700 GALLON OIL-INSULATED)
12	MT7G – FUEL GAS MODULE
13	MT7J – METERING MODULE
14	MT7C – PIGGING MODULE
15	MT7P – NORTH/SOUTH PIPERACK

GMT2 PAD QUANTITIES	
AREA OF TUNDRA COVER	14.0 ACRES
QUANTITY OF GRAVEL	152,000 CY

NOTE:
1. MINIMUM GRAVEL DEPTH 5.0' WITH 2:1 FILL SLOPES.
2. SEE SHEET 31 FOR WELL PAD TYPICAL SECTIONS.

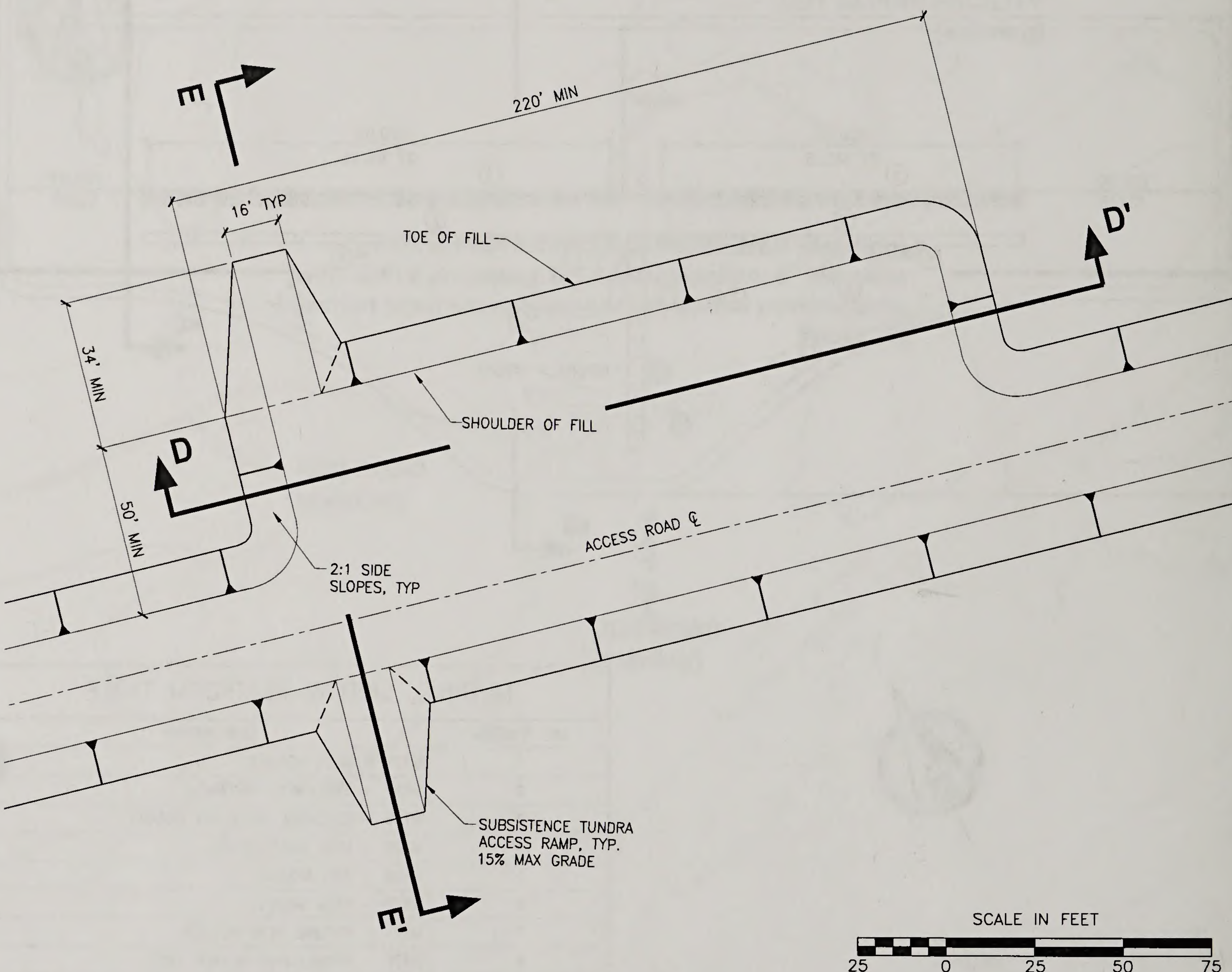
PND ENGINEERS, INC.

ConocoPhillips Alaska, Inc.

REFERENCE: POA XXXX-XX
APPLICANT: CPAI
PROPOSED: GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT: ALASKA

GMT2 PROPOSED PAD FOOTPRINT WITH 48 WELLS

SHEET **21** of **33** 05/11/17



SUBSISTENCE ACCESS/VEHICLE PULLOUT PAD QUANTITIES	
WEST VEHICLE PULLOUT PAD	
AREA OF TUNDRA COVER	0.4 ACRES
QUANTITY OF GRAVEL	3,100 CY
CENTRAL VEHICLE PULLOUT PAD	
AREA OF TUNDRA COVER	0.4 ACRES
QUANTITY OF GRAVEL	3,100 CY
EAST VEHICLE PULLOUT PAD	
AREA OF TUNDRA COVER	0.4 ACRES
QUANTITY OF GRAVEL	3,100 CY

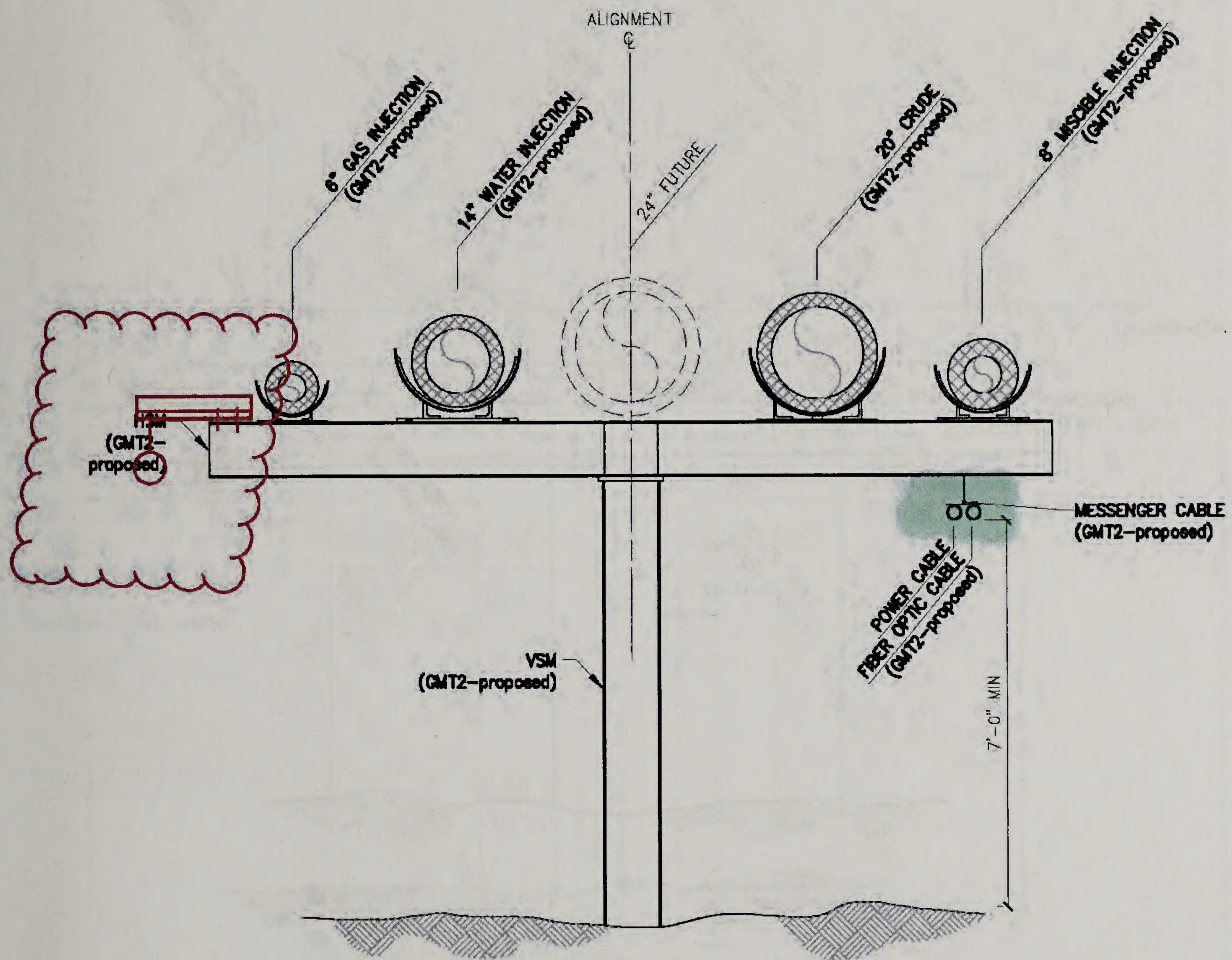
NOTE:
1. MINIMUM GRAVEL DEPTH 5.0' WITH 2:1 FILL SLOPES.
2. SEE SHEET 32 FOR SUBSISTENCE ACCESS/VEHICLE PULLOUT PAD TYPICAL SECTIONS.

PND ENGINEERS, INC.

ConocoPhillips Alaska, Inc.

PROPOSED TYPICAL SUBSISTENCE ACCESS/VEHICLE PULLOUT PAD FOOTPRINT

REFERENCE: POA XXXX-XX
APPLICANT: CPAI
PROPOSED: GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT: ALASKA
SHEET **22** of **33** 05/11/17

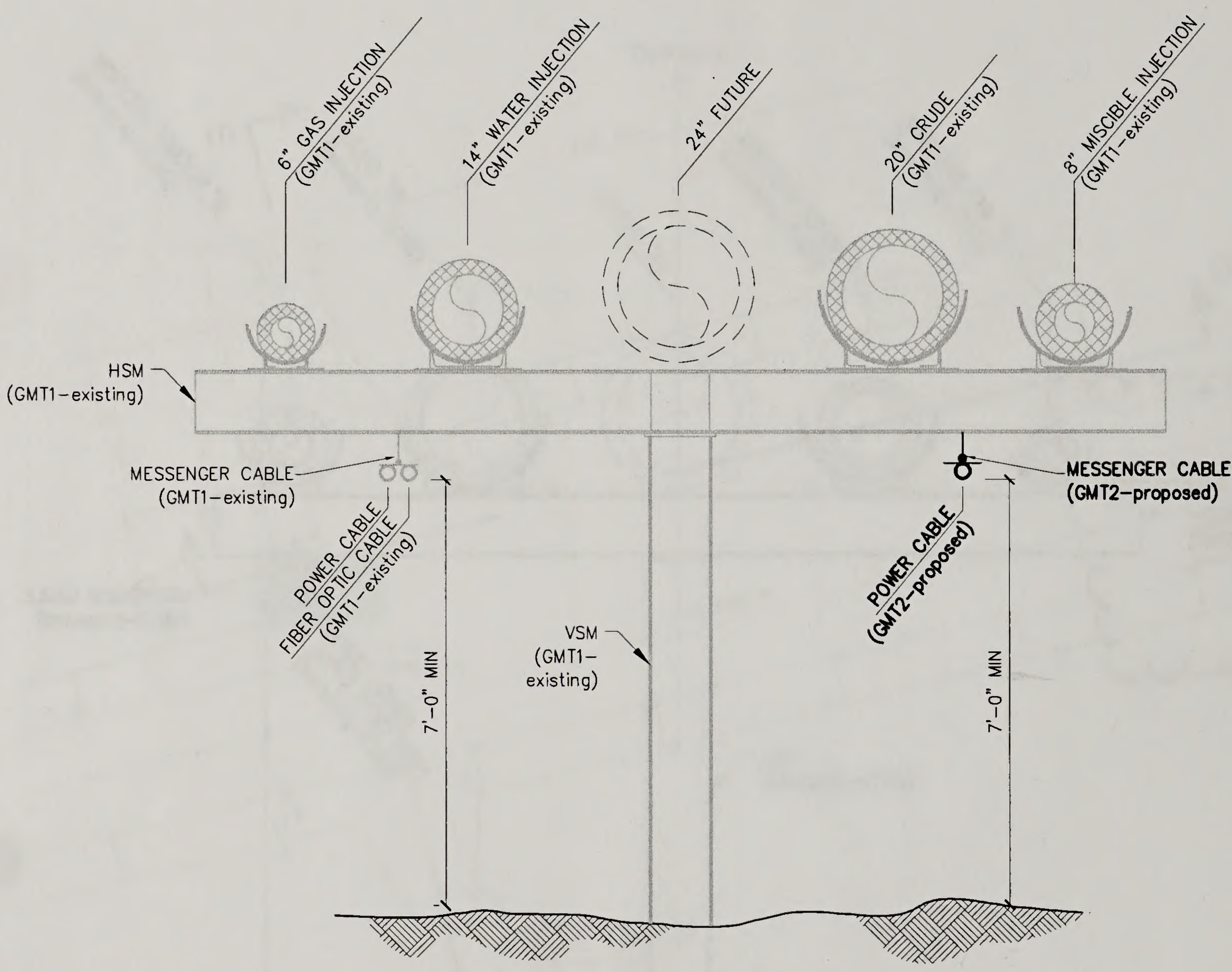


GMT2 TO GMT1 PROPOSED PIPELINE TYPICAL SECTION

PND ENGINEERS, INC.

ConocoPhillips Alaska, Inc.

REFERENCE:	POA XXXX-XX
APPLICANT:	CPAI
PROPOSED:	GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT:	ALASKA
SHEET **23** of **33**	05/11/17

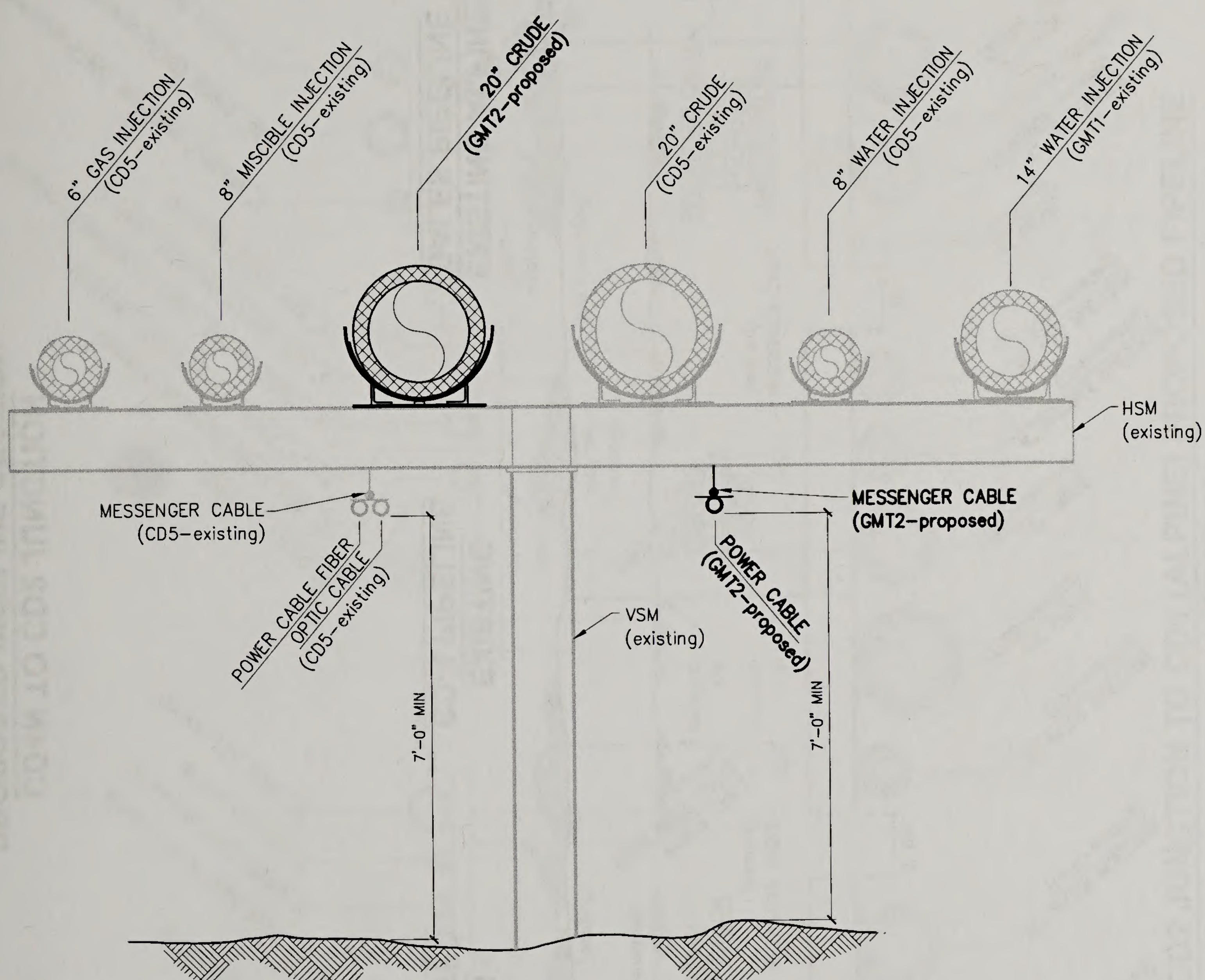


PND ENGINEERS, INC.

ConocoPhillips Alaska, Inc.

REFERENCE: POA XXXX-XX
APPLICANT: CPAI
PROPOSED: GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT: ALASKA
SHEET **24** of **33** 05/11/17

GMT1 TO CD5 PROPOSED PIPELINE TYPICAL SECTION

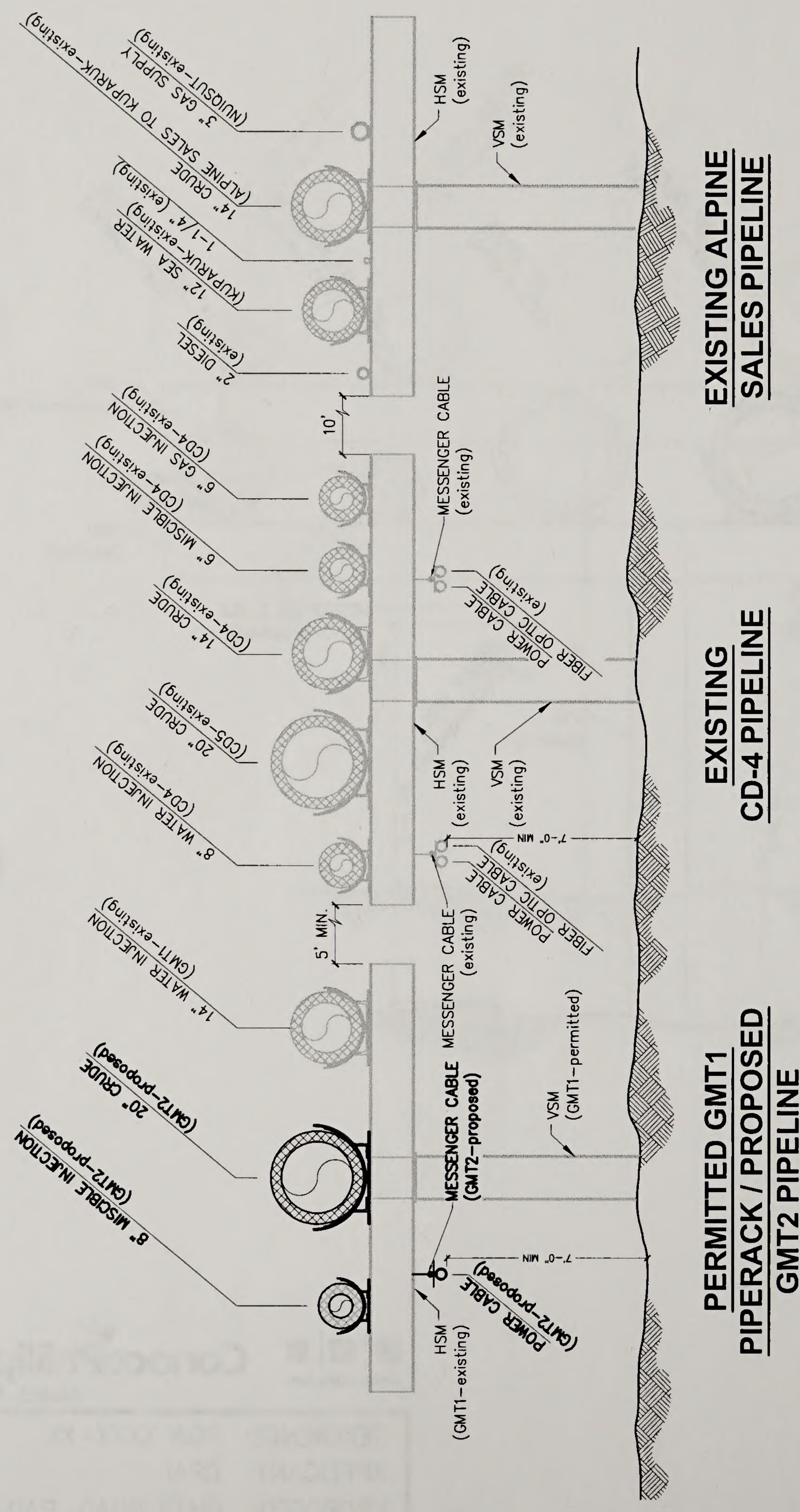


PND ENGINEERS, INC.

ConocoPhillips Alaska, Inc.

REFERENCE:	POA XXXX-XX
APPLICANT:	CPAI
PROPOSED:	GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT:	ALASKA
SHEET **25** of **33**	05/11/17

CD5 TO CD4N PROPOSED PIPELINE SECTION

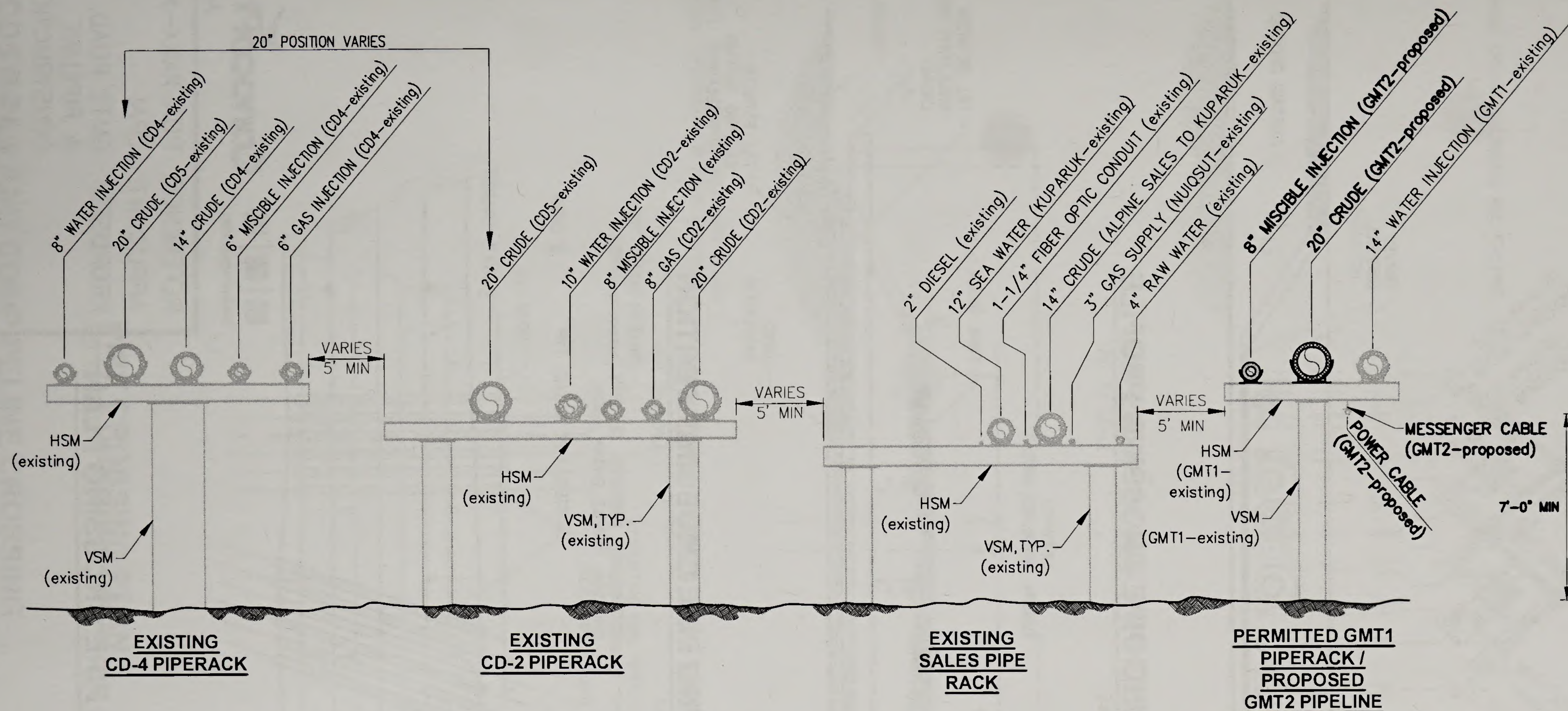


CD4N TO CD2 JUNCTION
PROPOSED PIPELINE SECTION

PND ENGINEERS, INC.

ConocoPhillips
Alaska, Inc.

REFERENCE:	POA XXXX–XX
APPLICANT:	CPAI
PROPOSED:	GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT:	ALASKA
SHEET **26** of **33**	05/11/17



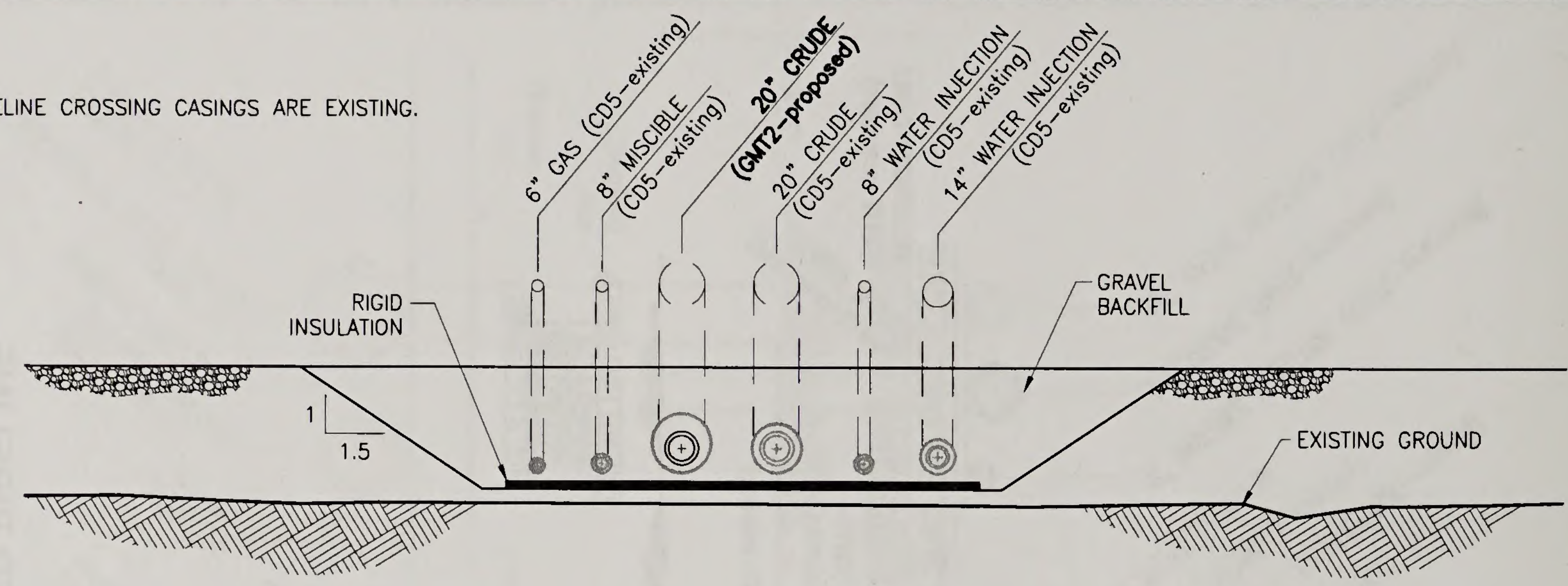
CD2 JUNCTION TO CD1 (ALPINE) PROPOSED PIPELINE SECTION

PND ENGINEERS, INC.

ConocoPhillips Alaska, Inc.

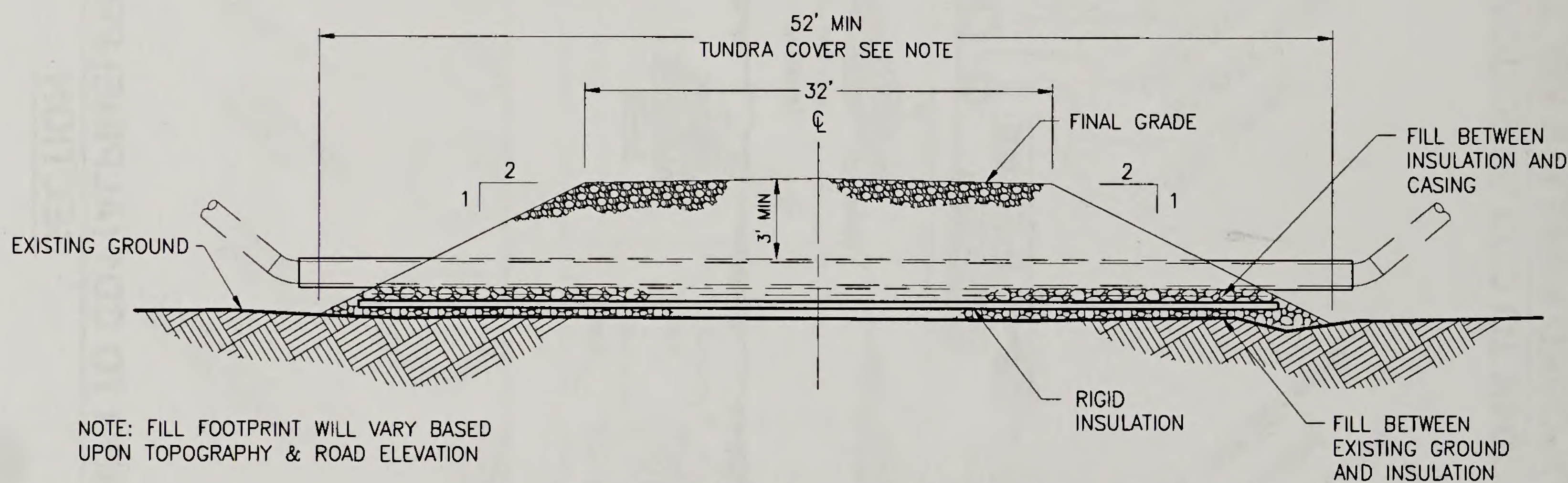
REFERENCE:	POA XXXX-XX
APPLICANT:	CPAI
PROPOSED:	GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT:	ALASKA

NOTE: PIPELINE CROSSING CASINGS ARE EXISTING.



EXISTING PIPE CROSSING PROFILE

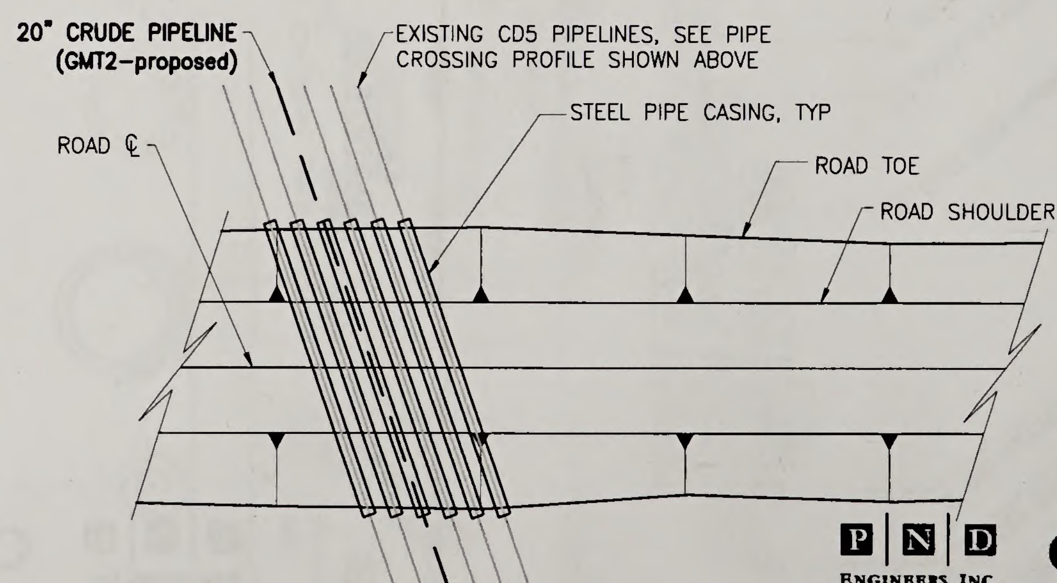
NOT TO SCALE



NOTE: FILL FOOTPRINT WILL VARY BASED UPON TOPOGRAPHY & ROAD ELEVATION

EXISTING PIPE CROSSING SECTION

NOT TO SCALE



PND ENGINEERS, INC.

ConocoPhillips Alaska, Inc.

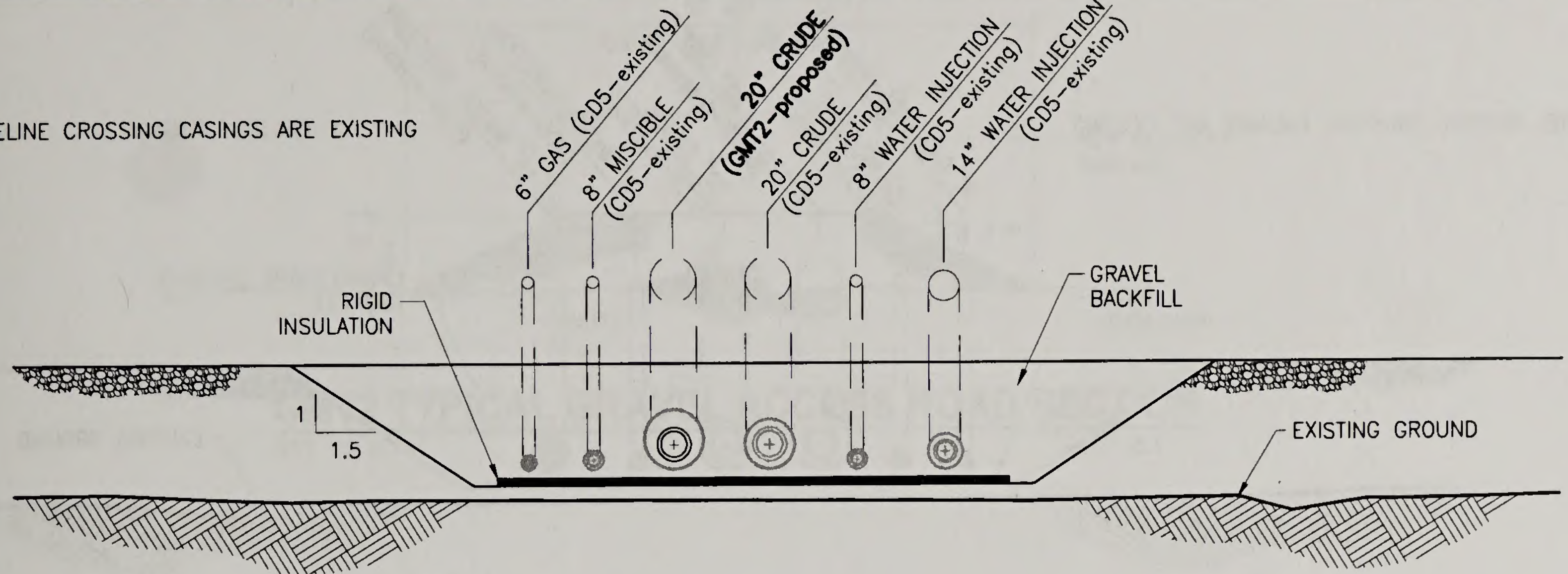
EXISTING PIPE CROSSING PLAN

NOT TO SCALE

GMT1 ROAD AT CD5 PIPELINE CROSSING

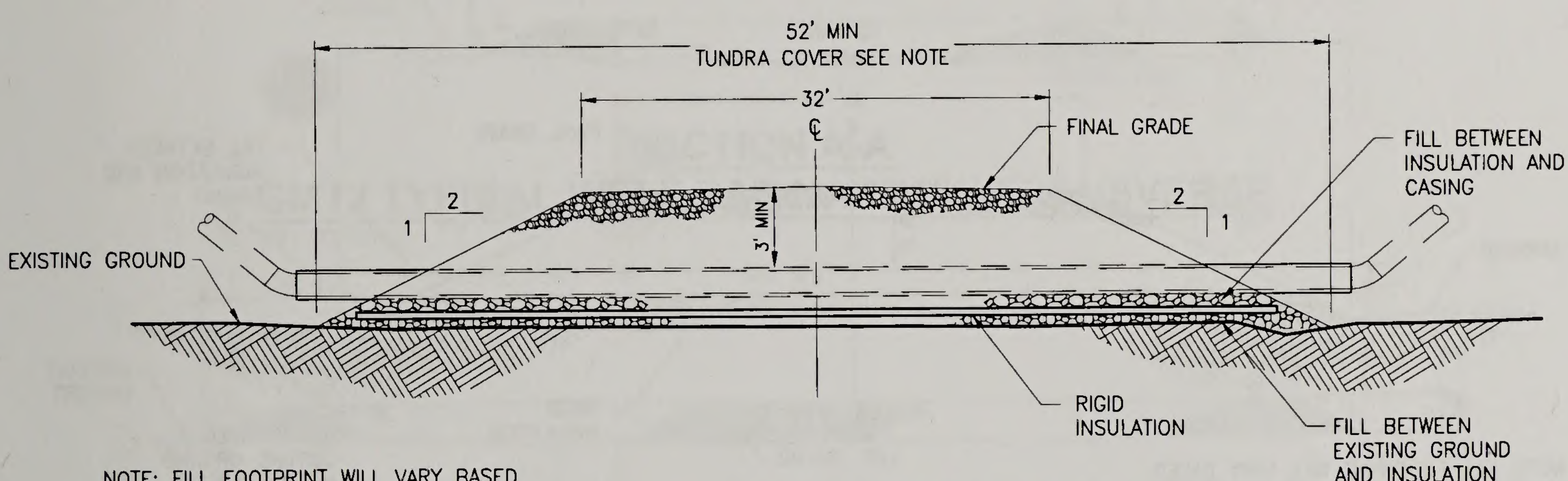
REFERENCE:	POA XXXX–XX
APPLICANT:	CPAI
PROPOSED:	GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT:	ALASKA
SHEET **28** of **33**	05/11/17

NOTE: PIPELINE CROSSING CASINGS ARE EXISTING



PIPE CROSSING PROFILE

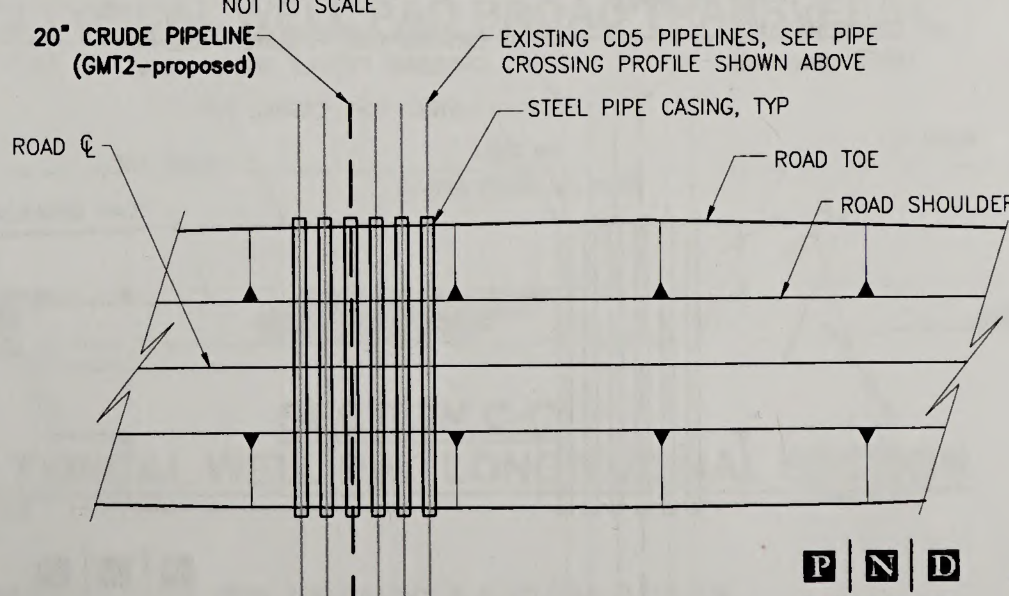
NOT TO SCALE



NOTE: FILL FOOTPRINT WILL VARY BASED UPON TOPOGRAPHY & ROAD ELEVATION

PIPE CROSSING SECTION

NOT TO SCALE



PIPE CROSSING PLAN

NOT TO SCALE

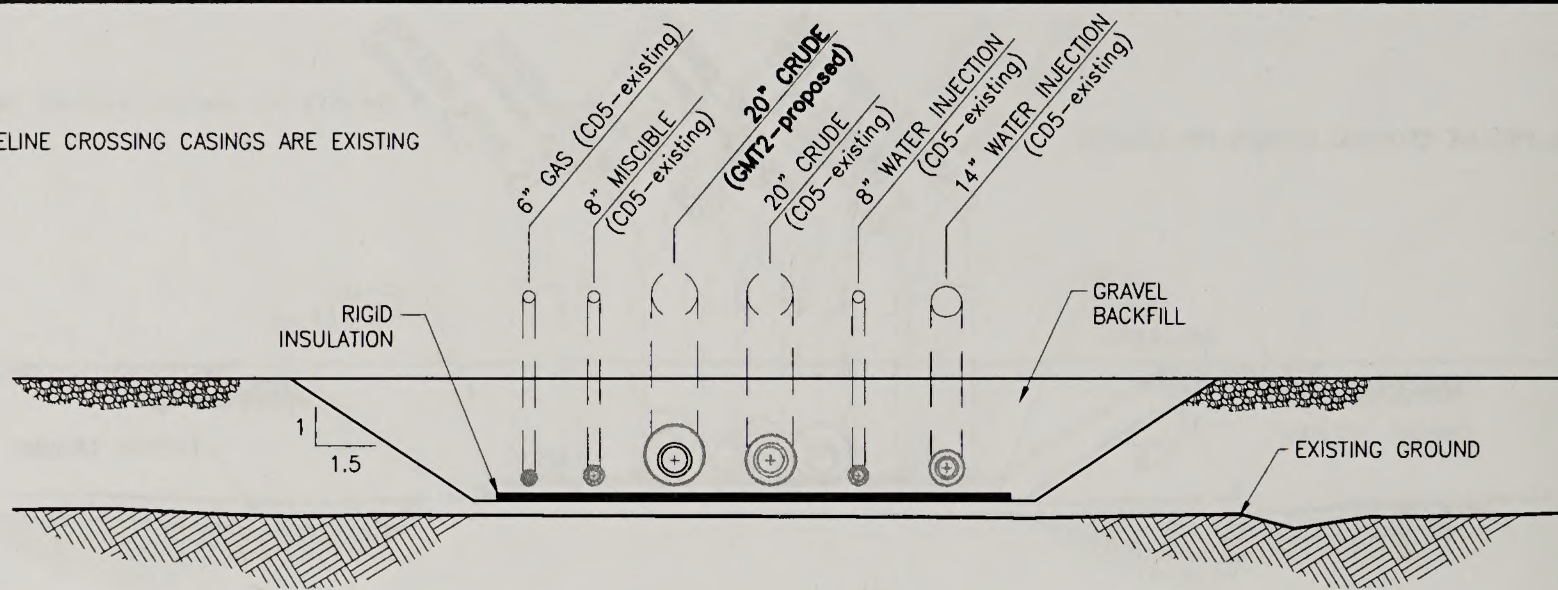
CD5 ROAD AND CD5 PIPELINE CROSSING

PND ENGINEERS, INC.

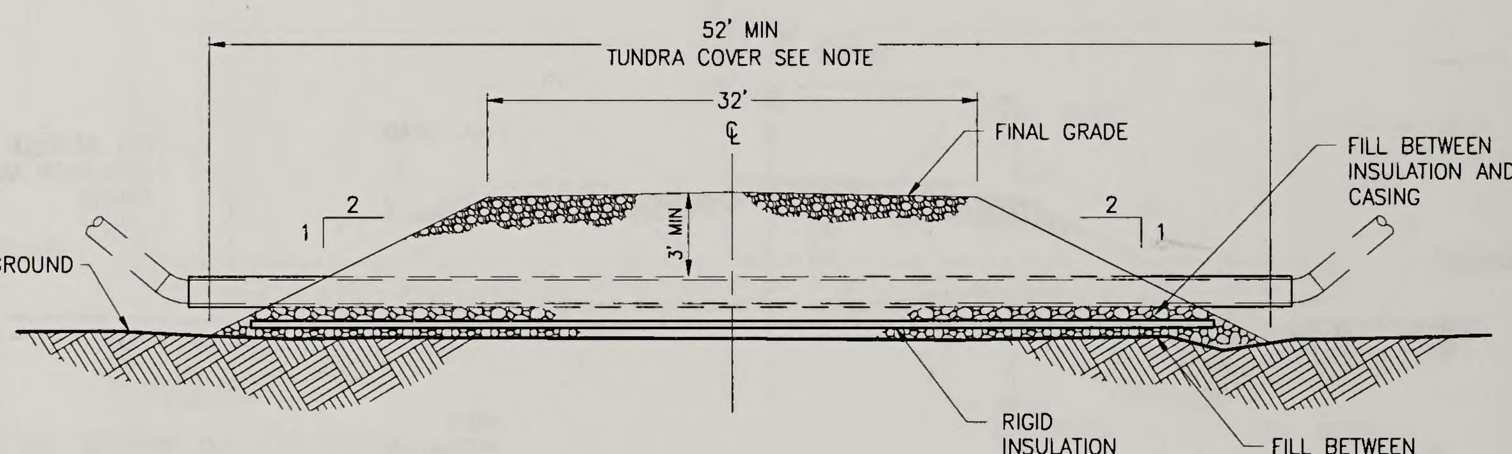
ConocoPhillips Alaska, Inc.

REFERENCE:	POA XXXX–XX
APPLICANT:	CPAI
PROPOSED:	GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT:	ALASKA
SHEET **29** of **33**	05/11/17

NOTE: PIPELINE CROSSING CASINGS ARE EXISTING

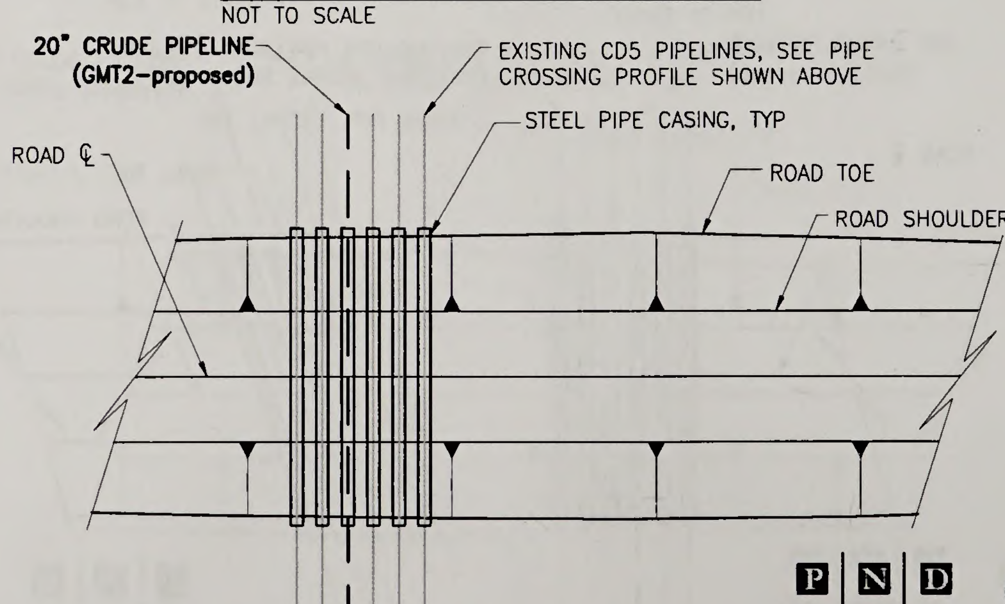


PIPE CROSSING PROFILE
NOT TO SCALE



NOTE: FILL FOOTPRINT WILL VARY BASED UPON TOPOGRAPHY & ROAD ELEVATION

PIPE CROSSING SECTION
NOT TO SCALE



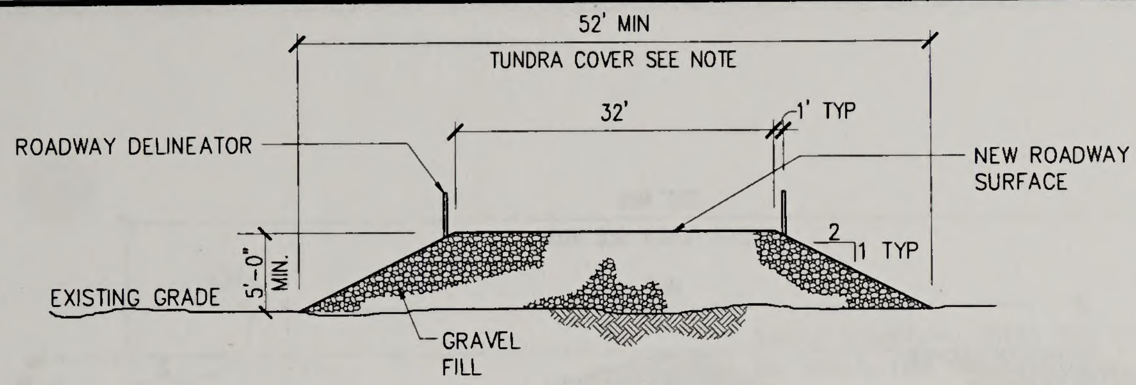
PIPE CROSSING PLAN
NOT TO SCALE

CD4 ROAD AND CD5 PIPELINE CROSSING

PND ENGINEERS, INC.

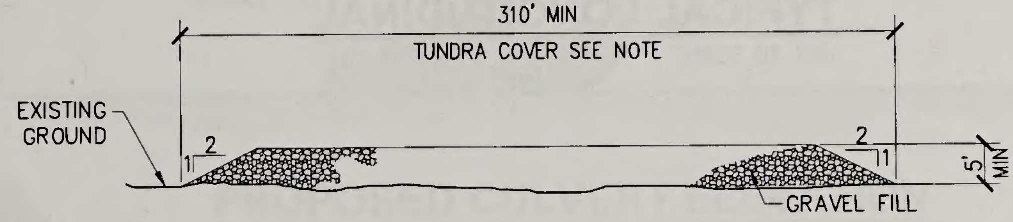
ConocoPhillips Alaska, Inc.

REFERENCE:	POA XXXX-XX
APPLICANT:	CPAI
PROPOSED:	GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT:	ALASKA
SHEET **30** of **33**	05/11/17



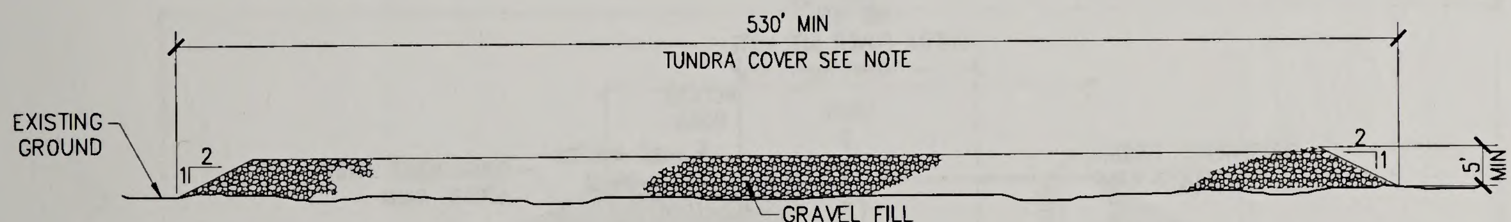
GMT2 TYPICAL GRAVEL ACCESS ROAD SECTION

NOT TO SCALE



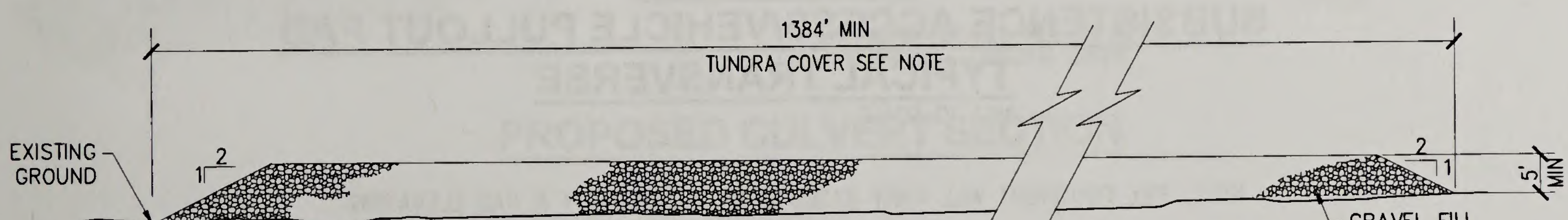
SECTION A-A'
GMT2 TYPICAL WELL PAD NARROW TRANSVERSE

NOT TO SCALE



SECTION B-B'
GMT2 TYPICAL WELL PAD BROAD TRANSVERSE

NOT TO SCALE



SECTION C-C'
GMT2 TYPICAL WELL PAD LONGITUDINAL SECTION

NOT TO SCALE

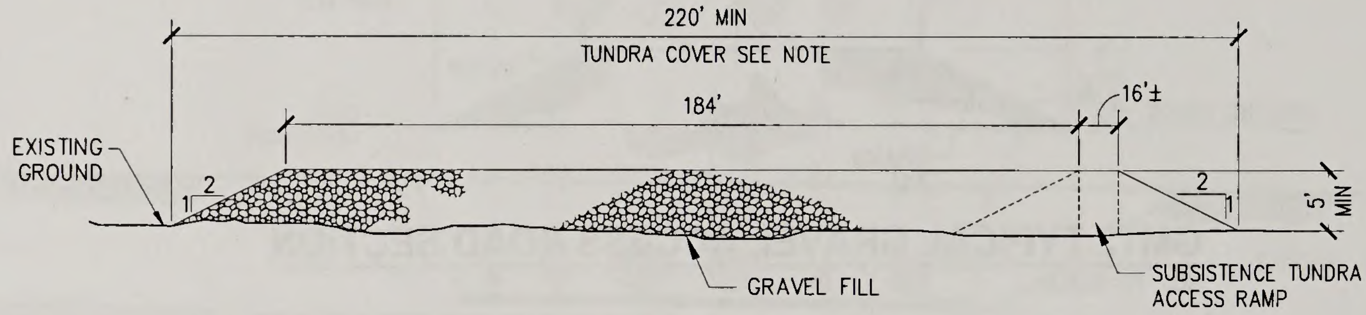
NOTE: FILL FOOTPRINT WILL VARY BASED UPON TOPOGRAPHY & ROAD/PAD ELEVATION

PND ENGINEERS, INC.

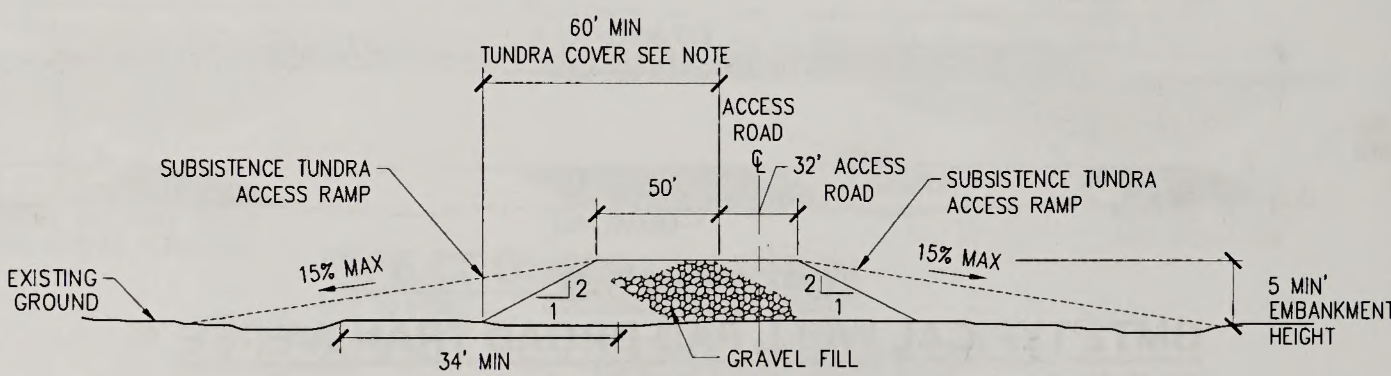
ConocoPhillips Alaska, Inc.

GMT2 PROPOSED TYPICAL ROAD & WELL PAD SECTIONS

REFERENCE:	POA XXXX-XX
APPLICANT:	CPAI
PROPOSED:	GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT:	ALASKA
SHEET **31** of **33**	05/11/17



SECTION D-D'
SUBSISTENCE ACCESS/VEHICLE PULLOUT PAD
TYPICAL LONGITUDINAL
NOT TO SCALE



SECTION E-E'
SUBSISTENCE ACCESS/VEHICLE PULLOUT PAD
TYPICAL TRANSVERSE
NOT TO SCALE

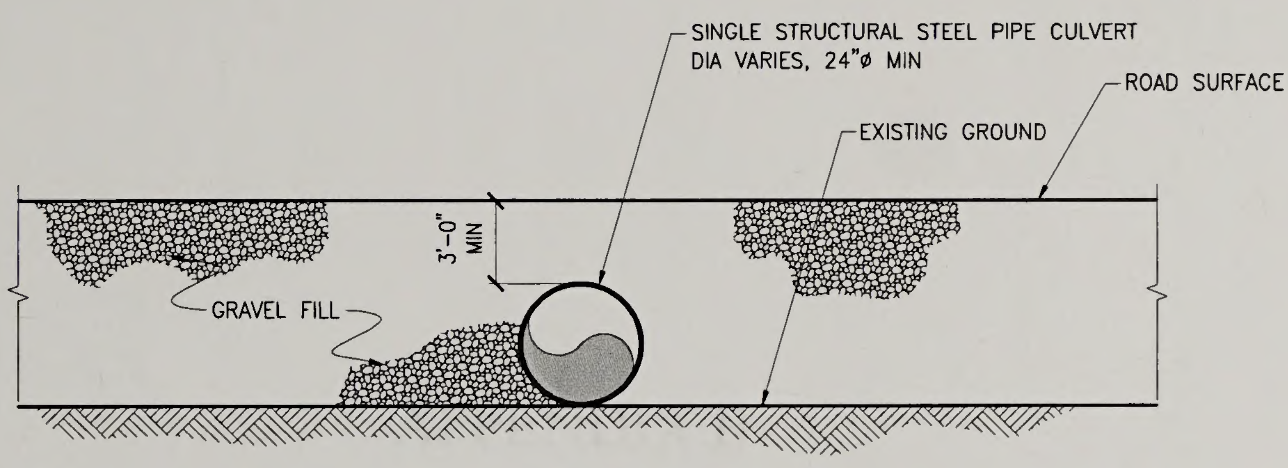
NOTE: FILL FOOTPRINT WILL VARY BASED UPON TOPOGRAPHY & PAD ELEVATION

PND ENGINEERS, INC.

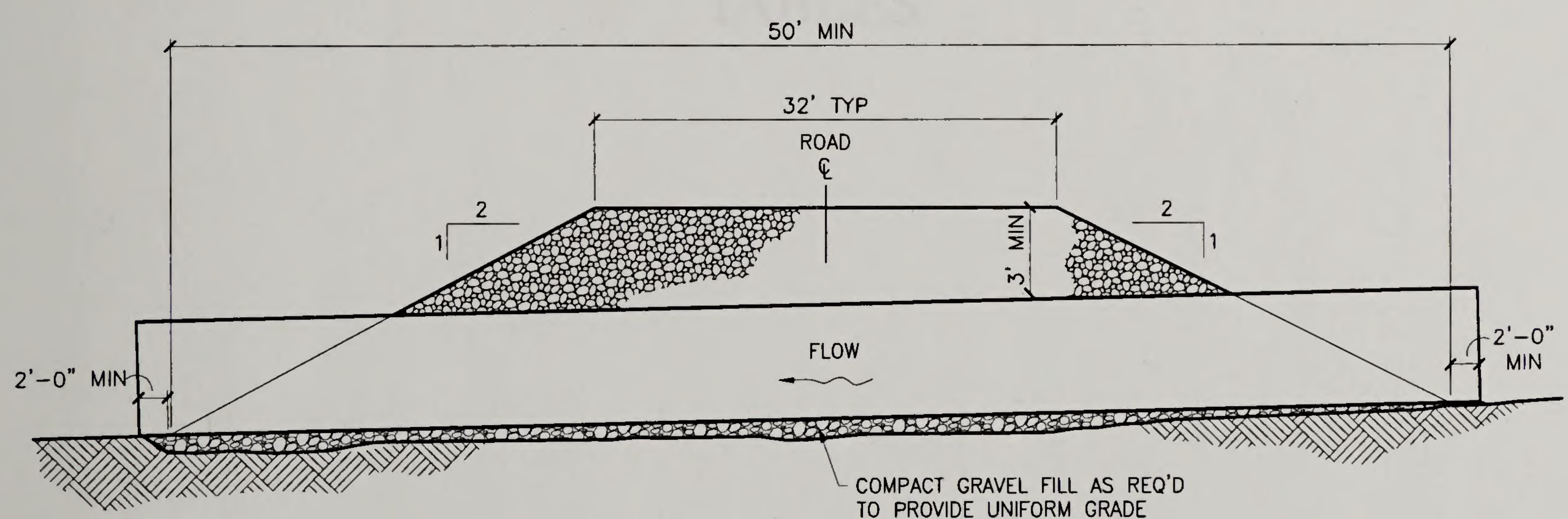
ConocoPhillips Alaska, Inc.

GMT2 PROPOSED SUBSISTENCE ACCESS/VEHICLE PULLOUT PAD TYPICAL SECTIONS

REFERENCE: POA XXXX-XX
APPLICANT: CPAI
PROPOSED: GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT: ALASKA
SHEET **32** of **33** 05/11/17



PROPOSED CULVERT ELEVATION



PROPOSED CULVERT SECTION

PROPOSED TYPICAL CROSS DRAINAGE CULVERT SECTION

PND ENGINEERS, INC.

ConocoPhillips Alaska, Inc.

REFERENCE:	POA XXXX-XX
APPLICANT:	CPAI
PROPOSED:	GMT2 ROAD, PAD, & PIPELINE CONSTRUCTION
AT:	ALASKA
SHEET **33** of **33**	05/11/17

APPENDIX B

VEHICLE TRIPS, AIRCRAFT TRAFFIC AND WATER USE TABLES

Aircraft Flights for Alternative A, Proposed Action - 2 YEAR CONSTRUCTION SCHEDULE [a]

Project Phase	Otter / CASA Flights Into CD1/APF [b]	DC-6 [b] Flights Into CD1/APF	Otter / CASA Flights Into GMT2	DC-6 / C-130 Flights Into GMT2	Helicopter [c,d] Flights Into GMT2/NPR-A	Total Flights Into GMT2/NPR-A	Total Flights
Construction (Year 1-2) [e]	125	0	0	0	538	538	663
Construction (Year 2-3) [f]	145	0	0	0	494	494	639
Drilling (Years 4-10, annual no. of flights) [g,h]	0	0	0	0	90	90	90
Drilling (Years 4-10, total flights for phase)	0	0	0	0	540	540	540
Post-Drilling Operations (annual no. of flights)	0	0	0	0	90	90	90
Post-Drilling Operations (total flights for phase) [i,j]	0	0	0	0	2,070	2,070	2,070
Project Life Total Flights	**270**	**0**	**0**	**0**	**3,642**	**3,642**	**3,912**

[a] A single "flight" is defined as a landing and subsequent takeoff. Monthly flight numbers were estimated by ConocoPhillips and provided for different aircraft types, flight locations, project activities, and project phases. Helicopter landings in NPR-A for ice-road clean-up were estimated at five landings per mile of ice road. Total flight numbers for drilling and post-drilling phases were calculated on the basis of estimated monthly flight numbers and an assumed post-construction project lifespan of 30 years.

[b] Otter/CASA flights will take off from Kuparuk or Deadhorse and land at CD1/Alpine Central Processing Facility. DC-6 flights will take off from Deadhorse and land at CD1/Alpine Central Processing Facility.

[c] Helicopter numbers refer to landings within the NPR-A. Helicopter visits to spill response equipment pre-staged as part of the GMT2 Project are included in helicopter landing numbers.

[d] Helicopter landings for ice road cleanup are estimated at five landings per mile of ice road. Ice road cleanup will only occur from May–September of Year 2 and Year 3. Helicopters will take off from Alpine CD1/Alpine Central Processing Facility and land along the ice road route. Helicopter flights during drilling and annual operations years will take off from CD1/Alpine Central Processing Facility and will support required monitoring and studies, survey work, and staging of spill response equipment. Landing/overflight areas within the NPR-A for monitoring helicopter flights will differ based on the study.

[e] Year 1-2 refers to November of year 1 through October of year 2.

[f] Year 2-3 refers to November of year 2 through December of year 3 (a 14-month period).

[g] Drilling (Years 4-10) represents January of year 4 through April of year 10.

[h] Drilling flights were calculated by multiplying the annual total by 6 years of drilling.

[i] Total trips for annual operations assumes a project lifespan of 23 years post drilling.

[j] Annual operations represents May of year 10 through December of year 32.

Aircraft Flights for Alternative B, 2 YEAR CONSTRUCTION SCHEDULE [a]

Project Phase	Otter / CASA Flights Into CD1/APF	DC-6 Flights Into CD1/APF	Otter / CASA Flights Into GMT2	DC-6 / C-130 Flights Into GMT2	Helicopter Flights Into GMT2/NPR-A	Total Flights Into GMT2/NPR-A	Total Flights
Construction (Year 1-2)	125	0	0	0	538	538	663
Construction (Year 2-3)	145	0	0	0	494	494	639
Drilling (Years 4-10, annual no. of flights)	0	0	0	0	90	90	90
Drilling (Years 4-10, total flights for phase)	0	0	0	0	540	540	540
Post-Drilling Operations (annual no. of flights)	0	0	0	0	90	90	90
Post-Drilling Operations (total flights for phase)	0	0	0	0	2,070	2,070	2,070
Project Life Total Flights	**270**	**0**	**0**	**0**	**3,642**	**3,642**	**3,912**

[a] A single "flight" is defined as a landing and subsequent takeoff. Monthly flight numbers were estimated by ConocoPhillips and provided for different aircraft types, flight locations, project activities, and project phases. Helicopter landings in NPR-A for ice-road clean-up were estimated at five landings per mile of ice road. Total flight numbers for drilling and post-drilling phases were calculated on the basis of estimated monthly flight numbers and an assumed post-construction project lifespan of 30 years.

[b] Otter/CASA flights will take off from Kuparuk or Deadhorse and land at CD1/Alpine Central Processing Facility. DC-6 flights will take off from Deadhorse and land at CD1/Alpine Central Processing Facility.

[c] Helicopter numbers refer to landings within the NPR-A. Helicopter visits to spill response equipment pre-staged as part of the GMT2 Project are included in helicopter landing numbers.

[d] Helicopter landings for ice road cleanup are estimated at five landings per mile of ice road. Ice road cleanup will only occur from May–September of Year 2 and Year 3. Helicopters will take off from Alpine CD1/Alpine Central Processing Facility and land along the ice road route. Helicopter flights during drilling and annual operations years will take off from CD1/Alpine Central Processing Facility and will support required monitoring and studies, survey work, and staging of spill response equipment. Landing/overflight areas within the NPR-A for monitoring helicopter flights will differ based on the study.

[e] Year 1-2 refers to November of year 1 through October of year 2.

[f] Year 2-3 refers to November of year 2 through December of year 3 (a 14-month period).

[g] Drilling (Years 4-10) represents January of year 4 through April of year 10.

[h] Drilling flights were calculated by multiplying the annual total by 6 years of drilling.

[i] Total trips for annual operations assumes a project lifespan of 23 years post drilling.

[j] Annual operations represents May of year 10 through December of year 32.

Aircraft Flights for Alternative A, Proposed Action and Alternative B - 3 YEAR CONSTRUCTION SCHEDULE [a]

Project Phase	Otter / CASA Flights Into CD1/APF [b]	DC-6 [c] Flights Into CD1/APF	Otter / CASA Flights Into GMT2	DC-6 / C-130 Flights Into GMT2	Helicopter [d] Flights Into GMT2/NPR-A	Total Flights Into GMT2/NPR-A	Total Flights
Construction (Year 0-1) [e]	125	0	0	0	409	409	534
Construction (Year 1-2) [f]	145	0	0	0	402	402	547
Construction (Year 2-3) [g]	145	0	0	0	310	310	445
Drilling (Years 4-10, annual no. of flights) [h,i]	0	0	0	0	90	90	50
Drilling (Years 4-10, total flights for phase)	0	0	0	0	540	540	540
Post-Drilling Operations (annual no. of flights) [j,k]	0	0	0	0	90	90	90
Post-Drilling Operations (total flights for phase)	0	0	0	0	2,070	2,070	2,070
Project Life Total Flights	**415**	**0**	**0**	**0**	**3,731**	**3,731**	**4,146**

[a] A single "flight" is defined as a landing and subsequent takeoff. Monthly flight numbers were estimated by ConocoPhillips and provided for different aircraft types, flight locations, project activities, and project phases. Helicopter landings in NPR-A for ice-road clean-up were estimated at five landings per mile of ice road. Total flight numbers for drilling and post-drilling phases were calculated on the basis of estimated monthly flight numbers and an assumed post-construction project lifespan of 30 years.

[b] Otter/CASA flights will take off from Kuparuk or Deadhorse and land at CD1/Alpine Central Processing Facility. DC-6 flights will take off from Deadhorse and land at CD1/Alpine Central Processing Facility.

[c] Helicopter numbers refer to landings within the NPR-A. Helicopter visits to spill response equipment pre-staged as part of the GMT2 Project are included in helicopter landing numbers.

[d] Helicopter landings for ice road cleanup are estimated at five landings per mile of ice road. Ice road cleanup will only occur from May–September of Year 2 and Year 3. Helicopters will take off from Alpine CD1/Alpine Central Processing Facility and land along the ice road route. Helicopter flights during drilling and annual operations years will take off from CD1/Alpine Central Processing Facility and will support required monitoring and studies, survey work, and staging of spill response equipment. Landing/overflight areas within the NPR-A for monitoring helicopter flights will differ based on the study.

[e] Year 0-1 refers to November of year 0 through October of year 1.

[f] Year 1-2 refers to November of year 1 through October of year 2.

[g] Year 2-3 refers to November of year 2 through December of year 3 (a 14-month period).

[h] Drilling (Years 4-10) represents January of year 4 through April of year 10.

[i] Drilling flights were calculated by multiplying the annual total by 6 years of drilling.

[j] Total trips for annual operations assumes a project lifespan of 23 years post drilling.

[k] Annual operations represents May of year 10 through December of year 32.

Aircraft Flights for Alternative C - 2 YEAR CONSTRUCTION SCHEDULE [a]

Project Phase	Otter / CASA Flights Into CD1/APF [b]	DC-6 [b] Flights Into CD1/APF	Otter / CASA Flights Into GMT2	DC-6 / C-130 Flights Into GMT2	Helicopter [c,d] Flights Into GMT2/NPR-A	Total Flights Into GMT2/NPR-A	Total Flights
Construction (Year 1-2) [e]	125	4	0	0	647	647	776
Construction (Year 2-3) [f]	145	0	865	193	413	1,471	1,616
Drilling (Years 4-10, annual no. of flights) [g,h]	0	0	983	227	143	1,353	1,353
Drilling (Years 4-10, total flights for phase)	0	0	6,126	1,399	858	8,383	8,383
Post-Drilling Operations (annual no. of flights) [i,j]	0	0	228	42	143	413	413
Post-Drilling Operations (total flights for phase)	0	0	5,281	974	3,289	9,544	9,544
Project Life Total Flights	**270**	**4**	**12,272**	**2,566**	**5,207**	**20,045**	**20,319**

[a] A single "flight" is defined as a landing and subsequent takeoff. Monthly flight numbers were estimated by ConocoPhillips and provided for different aircraft types, flight locations, project activities, and project phases. Helicopter landings in NPR-A for ice-road clean-up were estimated at five landings per mile of ice road. Total flight numbers for drilling and post-drilling phases were calculated on the basis of estimated monthly flight numbers and an assumed post-construction project lifespan of 30 years.

[b] Otter/CASA flights will take off from Kuparuk or CD1/Alpine Central Processing Facility and land at the GMT2 airstrip after airstrip construction is completed. DC-6/C130 flights will take off from Deadhorse and land at the GMT2 airstrip after airstrip construction is completed.

[c] Helicopter numbers refer to landings within the NPR-A. Helicopter visits to spill response equipment pre-staged as part of the GMT2 Project are included in helicopter landing numbers.

[d] Helicopter landings for ice road cleanup are estimated at five landings per mile of ice road. Ice road cleanup will occur from May–September from Year 2 until the end of the project. Helicopters would take off from the CD1/Alpine Central Processing Facility airstrip and land along the ice road route.

[e] Year 1-2 refers to November of year 1 through October of year 2.

[f] Year 2-3 refers to November of year 2 through December of year 3 (a 14-month period).

[g] Drilling (Years 4-10) represents January of year 4 through April of year 10.

[h] Drilling flights were calculated by multiplying the annual total by 6 years of drilling.

[i] Total trips for annual operations assumes a project lifespan of 23 years post drilling.

[j] Annual operations represents May of year 10 through December of year 32.

Aircraft Flights for Alternative C- 3 YEAR CONSTRUCTION SCHEDULE [a]

Project Phase	Otter / CASA Flights Into CD1/APF [b]	DC-6 [b] Flights Into CD1/APF	Otter / CASA Flights Into GMT2	DC-6 / C-130 Flights Into GMT2	Helicopter [c,d] Flights Into GMT2/NPR-A	Total Flights Into GMT2/NPR-A	Total Flights
Construction (Year 0-1) [e]	60	0	0	0	517	517	577
Construction (Year 1-2) [f]	65	4	0	0	287	287	356
Construction (Year 2-3) [g]	145	0	865	193	413	1,471	1,616
Drilling (Years 4-10, annual no. of flights) [h,i]	0	0	983	227	143	1,353	1,353
Drilling (Years 4-10, total flights for phase)	0	0	6,126	1,399	858	8,383	8,383
Post-Drilling Operations (annual no. of flights) [j,k]	0	0	228	42	143	413	413
Post-Drilling Operations (total flights for phase)	0	0	5,281	974	3,289	9,544	9,544
Project Life Total Flights	**270**	**4**	**12,272**	**2,566**	**5,363**	**20,202**	**20,476**

[a] A single "flight" is defined as a landing and subsequent takeoff. Monthly flight numbers were estimated by ConocoPhillips and provided for different aircraft types, flight locations, project activities, and project phases. Helicopter landings in NPR-A for ice-road clean-up were estimated at five landings per mile of ice road. Total flight numbers for drilling and post-drilling phases were calculated on the basis of estimated monthly flight numbers and an assumed post-construction project lifespan of 30 years.

[b] Otter/CASA flights will take off from Kuparuk or CD1/Alpine Central Processing Facility and land at the GMT2 airstrip after airstrip construction is completed. DC-6/C130 flights will take off from Deadhorse and land at the GMT2 airstrip after airstrip construction is completed.

[c] Helicopter numbers refer to landings within the NPR-A. Helicopter visits to spill response equipment pre-staged as part of the GMT2 Project are included in helicopter landing numbers.

[d] Helicopter landings for ice road cleanup are estimated at five landings per mile of ice road. Ice road cleanup will occur from May–September from Year 2 until the end of the project. Helicopters would take off from the CD1/Alpine Central Processing Facility airstrip and land along the ice road route.

[e] Year 1-2 refers to November of year 1 through October of year 2.

[f] Year 2-3 refers to November of year 2 through December of year 3 (a 14-month period).

[g] Drilling (Years 4-10) represents January of year 4 through April of year 10.

[h] Drilling flights were calculated by multiplying the annual total by 6 years of drilling.

[i] Total trips for annual operations assumes a project lifespan of 23 years post drilling.

[j] Annual operations represents May of year 10 through December of year 32.

[k] Annual operations represents May of year 10 through December of year 32.

ConocoPhillips' Baseline (current) Aircraft Flights Without Development of GMT2 (Alternative D) [a]

Project Phase	Otter / CASA Flights Into CD1/APF	DC-6 Flights Into CD1/APF	Otter / CASA Flights Into GMT2	DC-6 / C-130 Flights Into GMT2	Helicopter Flights Into GMT2/NPR-A	Total Flights Into GMT2/NPR-A	Total Flights
Construction (Year 1-2)	1,981	366	0	0	765	765	3,112
Construction (Year 2-3)	1,981	366	0	0	765	765	3,112
Drilling (Years 4-10, annual no. of flights)	1,981	366	0	0	765	765	3,112
Drilling (Years 4-10, total flights for phase)	12,429	2,318	0	0	4,590	4,590	19,337
Post-Drilling Operations (annual no. of flights)	1,981	366	0	0	765	765	3,112
Post-Drilling Operations (total flights for phase)	45,020	8,296	0	0	17,595	17,595	70,911
Project Life Total Flights	**61,421**	**11,345**	**0**	**0**	**23,715**	**23,715**	**96,481**

[a] Flight numbers are organized by GMT2 development phase to facilitate comparison with additional flight activity that is projected to occur with implementation of action alternatives A, B, and C. A single "flight" is defined as a landing and subsequent takeoff. Monthly flight numbers were estimated by ConocoPhillips and provided for different aircraft types, flight locations, and activities. Total flight numbers were calculated on the basis of estimated monthly flight numbers for the assumed 30-yr post-construction lifespan of the GMT2 project.

Vehicle Trips and Mileage Traveled for Alternative A, Proposed Action – 2 YEAR CONSTRUCTION SCHEDULE

Vehicle Type	Construction Season 1 Trips	Construction Season 1 Miles	Construction Season 2 Trips	Construction Season 2 Miles	Drilling Year 1 Trips	Drilling Year 1 Miles	Infill Drilling[a] Trips	Infill Drilling Miles	Routine Ops [b]Trips	Routine Ops Miles
Intercity Bus	2,900	32,900	5,700	45,700	0	0	0	0	0	0
Light Commercial Truck	11,300	114,100	22,300	178,100	800	19,600	1,200	29,100	500	9,400
Single Unit Short Haul Truck	78,900	778,100	43,800	180,500	5,300	133,500	7,800	194,700	200	3,100
Passenger Truck	500	6,300	700	4,000	0	0	0	0	0	0
Annual Total [c]	**93,600**	**931,400**	**72,500**	**408,300**	**6,100**	**153,100**	**9,000**	**223,800**	**700**	**12,500**

[a] Infill drilling refers to the period of time during which up to 48 development wells will be drilled on the GMT2 pad. Total trips and total miles for annual infill drilling assumes 6.33 years of drilling post construction.

[b] Routine operations will begin once infill drilling is complete. Routine operations assumes that the Alternative A wellwork crew will travel from CD1/Alpine Central Processing Facility as needed along the GMT1–GMT2 Access Road and an annual ice road will not be required. Total trips and total miles for routine operations assumes a project lifespan of 23 years post drilling.

[c] Totals are rounded to the nearest hundred. Trips are one way.

Vehicle Trips and Mileage Traveled for Alternative A, Proposed Action – 3 YEAR CONSTRUCTION SCHEDULE [a]

Vehicle Type	Construction Season 0 Trips	Construction Season 0 Miles	Construction Season 1 Trips	Construction Season 1 Miles	Construction Season 2 Trips	Construction Season 2 Miles
intercity bus	1,300	13,100	1,600	19,800	5,700	45,700
light commercial truck	5,400	57,200	5,900	56,900	22,300	178,100
single unit short haul truck	50,100	667,000	29,400	114,200	43,800	180,500
passenger truck	-	-	500	6,300	700	4,000
Annual Total [b]	**56,800**	**737,300**	**37,400**	**197,200**	**72,500**	**408,300**

[a] Under a three year construction schedule, vehicle trips and miles for drilling and routine operations will not change.

[b] Totals are rounded to the nearest hundred. Trips are one way.

Vehicle Trips and Mileage Traveled for Alternative B, Alternative Road Alignment – 2 YEAR CONSTRUCTION SCHEDULE

Vehicle Type	Construction Season 1 Trips	Construction Season 1 Miles	Construction Season 2 Trips	Construction Season 2 Miles	Drilling Year 1 Trips	Drilling Year 1 Miles	Infill Drilling Trips	Infill Drilling Miles	Routine Ops Trips	Routine Ops Miles
Intercity Bus	2,900	32,900	5,700	45,700	0	0	0	0	0	0
Light Commercial Truck	11,300	114,100	22,300	178,100	800	20,880	1,200	30,300	500	10,100
Single Unit Short Haul Truck	83,500	870,500	43,900	181,500	5,300	138,330	7,800	202,500	200	3,400
Passenger Truck	500	6,300	700	4,000	0	0	0	0	0	0
Annual Total	**98,200**	**1,023,800**	**72,600**	**409,300**	**6,100**	**159,210**	**9,000**	**232,800**	**700**	**13,500**

[a] Infill drilling refers to the period of time during which up to 48 development wells will be drilled on the GMT2 pad. Total trips and total miles for annual infill drilling assumes 6.33 years of drilling post construction.

[b] Routine operations will begin once infill drilling is complete. Routine operations assumes that the Alternative A wellwork crew will travel from CD1/Alpine Central Processing Facility as needed along the GMT1–GMT2 Access Road and an annual ice road will not be required. Total trips and total miles for routine operations assumes a project lifespan of 23 years post drilling.

[c] Totals are rounded to the nearest hundred. Trips are one way.

Vehicle Trips and Mileage Traveled for Alternative B, Alternative Road Alignment – 3 YEAR CONSTRUCTION SCHEDULE [a]

Vehicle Type	Construction Season 0 Trips	Construction Season 0 Miles	Construction Season 1 Trips	Construction Season 1 Miles	Construction Season 2 Trips	Construction Season 2 Miles
intercity bus	1,300	13,100	1,600	19,800	5,700	45,700
light commercial truck	5,400	57,200	5,900	56,900	22,300	178,100
single unit short haul truck	54,700	759,400	29,400	114,200	43,900	181,500
passenger truck	-	-	500	6,300	700	4,000
Annual Total [b]	**61,400**	**829,700**	**37,400**	**197,200**	**72,600**	**409,300**

[a] Under a three year construction schedule, vehicle trips and miles for drilling and routine operations will not change.

[b] Totals are rounded to the nearest hundred. Trips are one way.

Vehicle Trips and Mileage Traveled for Alternative C, Roadless Development – 2 YEAR CONSTRUCTION SCHEDULE

Vehicle Type	Construction Season 1 Trips	Construction Season 1 Miles	Construction Season 2 Trips	Construction Season 2 Miles	Drilling Year 1 Trips	Drilling Year 1 Miles	Infill Drilling Trips	Infill Drilling Miles	Routine Ops Trips	Routine Ops Miles
Intercity Bus	2,800	30,300	5,900	29,700	0	0	0	0	0	0
Light Commercial Truck	11,700	105,600	19,500	90,200	800	800	10,200	10,200	16,000	48,300
Single Unit Short Haul Truck	91,700	1,214,400	49,200	212,000	4,500	4,500	12,300	160,900	5,800	22,000
Passenger Truck	500	6,300	500	4,000	0	0	0	0	0	0
Annual Total	**106,700**	**1,356,600**	**75,100**	**335,900**	**5,300**	**5,300**	**22,500**	**171,100**	**21,800**	**70,300**

[a] Trips are one way. Construction trips are performed on the ice road. Drilling and routine operation trips are primarily performed on the 1-mile gravel road connecting the drill pad to the camp pad.

[b] Infill drilling refers to the period of time during which up to 48 development wells will be drilled on the GMT2 pad. Total trips and total miles assumes 6.33 years of annual infill drilling.

[c] Total trips and total miles for routine operations assumes a project lifespan of 23 years post drilling.

[d] Totals are rounded to the nearest hundred.

Vehicle Trips and Mileage Traveled for Alternative C, Roadless Development – 3 YEAR CONSTRUCTION SCHEDULE [a]

Vehicle Type	Construction Season 0 Trips	Construction Season 0 Miles	Construction Season 1 Trips	Construction Season 1 Miles	Construction Season 2 Trips	Construction Season 2 Miles
intercity bus	1,100	8,900	1,700	21,400	5,900	29,700
light commercial truck	5,500	58,200	6,200	47,400	19,500	90,200
single unit short haul truck	60,600	1,092,200	31,700	125,300	49,200	212,000
passenger truck	-	-	500	6,300	500	4,000
Annual Total [b]	**67,200**	**1,159,300**	**40,100**	**200,400**	**75,100**	**335,900**

[a] Under a three year construction schedule, vehicle trips and miles for drilling and routine operations will not change.

[b] Totals are rounded to the nearest hundred. Trips are one way.

Water Use for Alternative A, Proposed Action – 2 YEAR CONSTRUCTION SCHEDULE [a]

Project Phase	Project Component	Water Requirement (million gallons [MG])
Construction Season 1	Ice Road [b]: 52.6 miles	74.2 MG
Construction Season 1	Ice Pad	43.8 MG
Construction Season 1	Winter Work Force	3.7 MG
Construction Season 1	Construction Miscellaneous	1.0 MG
Construction Season 2	Ice Road: 43.9 miles	76.1 MG
Construction Season 2	Ice Pad	33.8 MG
Construction Season 2	Winter Work Force	3.7 MG
Construction Season 2	Construction Miscellaneous	1.0 MG
Construction Season 2	Summer Work Force	1.7 MG
Construction Total	**All Components**	**239 MG**
Drilling	Ice Pad [c]	2.5 MG
Drilling	Drilling Water	13.5 MG
Drilling	Camp Water	2.7 MG
Drilling	Drilling Miscellaneous	1.0 MG
Drilling Total [d]	**All Components**	**140.6 MG (19.8 MG annually)**
Routine Operations	Ice Pad	0.5 MG
Routine Operations Total [e]	**All Components**	**15.0 MG (0.5 MG annually)**
Project Life Total	**All Components**	**395 MG**

[a] Camp water usage for all locations and alternatives is 100 gallons per person per day.

[b] Typical ice road water requirement is 1 MG per mile for 35-foot wide ice road. Wider ice roads are required for pipeline construction; water use for pipeline construction ice roads were ratioed from the 35-foot wide ice road.

[c] A 10-acre ice pad would be needed (2.5 MG per 10 acres) to support drilling.

[d] Drilling water requirement is based on 2 MG per well; drilling a well takes 54 days. Water use was estimated for the drilling phase assuming 48 wells will be drilled over 7.1 years.

[e] Water use for routine operations assumes a 30 year project lifespan post construction. Water use for routine operations is not included in the Drilling total for the overlapping years.

Water Use for Alternative A, Proposed Action – 3 YEAR CONSTRUCTION SCHEDULE [a]

Project Phase	Project Component	Water Requirement (MG)
Construction Season 0	Ice Road: 25.6 miles [b]	36.1
Construction Season 0	Ice Pad:	25.0
Construction Season 0	Winter Work Force	3.7
Construction Season 0	Construction Miscellaneous	1.0
Construction Season 1	Ice Road: 27.0 miles	38.1
Construction Season 1	Ice Pad:	18.8
Construction Season 1	Winter Work Force	3.7
Construction Season 1	Construction Miscellaneous	1.0
Construction Season 2	Ice Road: 43.9 miles	76.1
Construction Season 2	Ice Pad:	33.8
Construction Season 2	Winter Work Force	3.7
Construction Season 2	Construction Miscellaneous	1.0
Construction Season 2	Summer Workforce	1.7
Construction Total [c]		**243.7**

[a] Camp water usage for all locations and alternatives is 100 gallons per person per day.

[b] Typical ice road water requirement is 1 MG per mile for 35-foot wide ice road. Wider ice roads are required for pipeline construction; water use for pipeline construction ice roads were ratioed from the 35-foot wide ice road.

[c] Under a three year construction schedule, water use for drilling and routine operations will not change.

Water Use for Alternative B, Alternate Road Alignment – 2 YEAR CONSTRUCTION SCHEDULE [a]

Project Phase	Project Component	Water Requirement (million gallons [MG])
Construction Season 1	Ice Road [b]: 52 miles	75 MG
Construction Season 1	Ice Pad	43.8 MG
Construction Season 1	Winter Work Force	3.7 MG
Construction Season 1	Construction Miscellaneous	1.0 MG
Construction Season 2	Ice Road: 43.3 miles	78.3 MG
Construction Season 2	Ice Pad	33.8 MG
Construction Season 2	Winter Work Force	3.7 MG
Construction Season 2	Construction Miscellaneous	1.0 MG
Construction Season 2	Summer Work Force	1.7 MG
Construction Total	**All Components**	**242 MG**
Drilling	Ice Pad [c]	2.5 MG
Drilling	Drilling Water	13.5 MG
Drilling	Camp Water	2.7 MG
Drilling	Drilling Miscellaneous	1.0 MG
Drilling Total [d]	**All Components**	**140.6 MG (19.8 MG annually)**
Routine Operations	Ice Pad	0.5 MG
Routine Operations Total [e]	**All Components**	**15.0 MG (0.5 MG annually)**
Project Life Total	**All Components**	**398 MG**

[a] Camp water usage for all locations and alternatives is 100 gallons per person per day.

[b] Typical ice road water requirement is 1 MG per mile for 35-foot wide ice road. Wider ice roads are required for pipeline construction; water use for pipeline construction ice roads were ratioed from the 35-foot wide ice road.

[c] A 10-acre ice pad would be needed (2.5 MG per 10 acres) to support drilling.

[d] Drilling water requirement is based on 2 MG per well; drilling a well takes 54 days. Water use was estimated for the drilling phase assuming 48 wells will be drilled over 7.1 years.

[e] Water use for routine operations assumes a 30 year project lifespan post construction. Water use for routine operations is not included in the Drilling total for the overlapping years.

Water Use for Alternative B, Alternate Road Alignment – 3 YEAR CONSTRUCTION SCHEDULE [a]

Project Phase	Project Component	Water Requirement (MG)
Construction Season 0	Ice Road: 25.0 miles [b]	36.0
Construction Season 0	Ice Pad:	25.0
Construction Season 0	Winter Work Force	3.7
Construction Season 0	Construction Miscellaneous	1.0
Construction Season 1	Ice Road: 27.0 miles	39.0
Construction Season 1	Ice Pad:	18.8
Construction Season 1	Winter Work Force	3.7
Construction Season 1	Construction Miscellaneous	1.0
Construction Season 2	Ice Road: 43.3 miles	78.3
Construction Season 2	Ice Pad:	33.8
Construction Season 2	Winter Work Force	3.7
Construction Season 2	Construction Miscellaneous	1.0
Construction Season 2	Summer Workforce	1.7
Construction Total [c]		**246.7**

[a] Camp water usage for all locations and alternatives is 100 gallons per person per day.

[b] Typical ice road water requirement is 1 MG per mile for 35-foot wide ice road. Wider ice roads are required for pipeline construction; water use for pipeline construction ice roads were ratioed from the 35-foot wide ice road.

[c] Under a three year construction schedule, water use for drilling and routine operations will not change.

Water Use for Alternative C, Roadless Development – 2 YEAR CONSTRUCTION SCHEDULE [a]

Project Phase	Project Component	Water Requirement (million gallons [MG])
Construction Season 1	Ice Road [b]: 51.6 miles	72.8 MG
Construction Season 1	Ice Pad	51.3 MG
Construction Season 1	Winter Work Force (Alpine)	3.7 MG
Construction Season 1	Construction Miscellaneous	1.0 MG
Construction Season 2	Ice Road: 51.2 miles	83.4 MG
Construction Season 2	Ice Pad	43.8 MG
Construction Season 2	Winter Work Force (Alpine)	3.7 MG
Construction Season 2	Winter Work Force (Remote Facilities)	1.6 MG
Construction Season 2	Construction Miscellaneous	1.0 MG
Construction Season 2	Summer Work Force	3.4 MG
Construction Total	**All Components**	**266 MG**
Drilling	Ice Pad [c]	2.5 MG
Drilling	Ice Road: 7.0 miles	7.0 MG
Drilling	Drilling Water	13.5 MG
Drilling	Camp Water	7.3 MG
Drilling	Drilling Miscellaneous	1.0 MG
Drilling Total [d]	**All Components**	**222 MG**
Routine Operations	Ice Pad	0.5 MG
Routine Operations	Ice Road	7.0 MG
Routine Operations	Ops Camp Support	0.91
Routine Operations Total [e]	**All Components**	**203**
Project Life Total	**All Components**	**691 MG**

[a] Camp water usage for all locations and alternatives is 100 gallons per person per day.

[b] Typical ice road water requirement is 1 MG per mile for 35-foot wide ice road. Wider ice roads are required for pipeline construction; water use for pipeline construction ice roads were ratioed from the 35-foot wide ice road.

[c] A 10-acre ice pad would be needed (2.5 MG per 10 acres) to support drilling.

[d] Drilling water requirement is based on 2 MG per well; drilling a well takes 54 days. Water use was estimated for the drilling phase assuming 48 wells will be drilled over 7.1 years.

[e] Water use for routine operations assumes a 30 year project lifespan post construction. Water use for routine operations is not included in the Drilling total for the overlapping years. The annual ice road for the 7.1 years of drilling is accounted for in the Drilling Total.

Water Use for Alternative C, Roadless Development – 3 YEAR CONSTRUCTION SCHEDULE [a]

Project Phase	Project Component	Water Requirement (MG)
Construction Season 0	Ice Road: 25.6 miles [b]	36.1
Construction Season 0	Ice Pad:	25.0
Construction Season 0	Winter Work Force	3.7
Construction Season 0	Construction Miscellaneous	1.0
Construction Season 1	Ice Road: 26.0 miles	36.7
Construction Season 1	Ice Pad:	26.3
Construction Season 1	Winter Work Force	3.7
Construction Season 1	Construction Miscellaneous	1.0
Construction Season 2	Ice Road: 51.2 miles	83.4
Construction Season 2	Ice Pad:	43.8
Construction Season 2	Winter Work Force - Alpine	3.7
Construction Season 2	Winter Work Force - Remote	1.6
Construction Season 2	Construction Miscellaneous	1.0
Construction Season 2	Summer Workforce	3.4
Construction Total [c]		**270.4**

[a] Camp water usage for all locations and alternatives is 100 gallons per person per day.

[b] Typical ice road water requirement is 1 MG per mile for 35-foot wide ice road. Wider ice roads are required for pipeline construction; water use for pipeline construction ice roads were ratioed from the 35-foot wide ice road.

[c] Under a three year construction schedule, water use for drilling and routine operations will not change.

APPENDIX C

PASSIVE ACOUSTIC MONITORING PROJECT METHODOLOGY

APPENDIX C: 2016 PASSIVE ACOUSTIC MONITORING PROJECT METHODOLOGY

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Passive Acoustic Monitoring Systems

We deployed 20 Passive Acoustic Monitoring (PAM) systems in June 2016 to quantify aircraft activity and noise levels over Nuiqsut's subsistence hunting areas during peak caribou hunting season. Sites were spaced approximately 10 km apart along the Colville River from its delta south to the Anaktuvuk River confluence, as well as along Fish Creek west of Nuiqsut (Figure D1). We collaborated with community organizations and Tribal entities including the Kuukpik Subsistence Oversight Panel (KSOP, Inc.) to locate our monitoring sites near caribou hunting areas where aircraft have been observed

We followed methods developed by the Natural Sounds and Night Skies Division (NSNSD) of the National Parks Service (NPS) for system design and configuration (NPS 2013), but we modified equipment selection to reduce costs while maintaining the acoustic parameters necessary to record aircraft noise.

A Roland R-05 Digital Audio Recorder (DAR, Roland Corporation 2010, Los Angeles, CA) recorded sound continuously for 30-day intervals at a sampling rate of 44.1 kHz and bit rate of 96 kbps. Sound files were stored in mP3 format on a removable 32 GB SDHC data card. We hung the DAR inside a self-crafted windscreen capped with a water-sealed plastic saucer. We mounted the windscreen-DAR component onto a galvanized steel pole so that the recording device was suspended ~1.5 - 2.4 m above ground level (Figure D1). The power supply at each site comprised 8 D-cell alkaline batteries wired in parallel and enclosed in a waterproof box at the base of the pole. We replaced batteries and SDHC cards every ~24-30 days until 09

September 2016 unless a site could not be reached due to logistical constraints. We avoided the use of research aircraft for transport to our field sites and opted instead to travel by boat with a local driver. Our reliance on river conditions forced us to abandon several upriver sites in late July when water levels dropped below the depth navigable by the outboard motor boats used by most Nuiqsut residents. This caused substantial variation in the length of sound recordings across sites. PAM systems recorded between 479 and 1788 hr (20-75 days) of sound per site from 03 June to 28 August 2016.

Identifying Aircraft events through Audiovisual Analysis

After downloading sound data from SD cards, we converted mp3 audio files into a format appropriate for sound visualization using the AUDIO2NVSPL software (NPS 2008, Fort Collins, CO). This formatting translates audio into one-second Sound Pressure Levels (SPL) and 1/3 octave frequency spectral bands from which spectrograms can be generated.

To identify aircraft sound events, we conducted audiovisual analysis for all hourly spectrograms at all study sites using the Sound Pressure Level Annotation Tool (SPLAT) from the Acoustic Monitoring Toolbox version 1.0.5591 (NPS 2008, Fort Collins, CO). We followed protocols for audiovisual analysis outlined in the NSNSD training manual (NPS 2013). Trained users identified aircraft sound events by the spectrographic signature and simultaneous audio playback. Users then annotated audible events with a unique source ID code corresponding to aircraft type: high-altitude jet, propeller plane, or helicopter. Spectral information of annotated events (e.g. event date, time, source ID, duration, frequency range, maximum SPL, Sound Exposure Level (SEL), username, and date of annotation) is catalogued by the SPLAT software into a single Source ID(SRCID) file for each site.

Aircraft Data Analysis

Once audiovisual analysis was completed for all days of recording at all sites, we compiled SRCID files from every site into a single dataset using the data management packages tidyr (Wickham 2017) and dplyr (Wickham and Francois 2016) in R version 3.2.4 (R Core Team 2016). Propeller planes were aggregated into one source code for 'aircraft type' because the sound signatures produced by small propeller aircraft and larger turboprop aircraft could not be discriminated reliably via audiovisual analysis. The sound and appearance of an aircraft signature can vary with wind speed, wind direction, and the distance of the plane from the recording device, none of which were measured at our field sites.

Metrics files were generated by the month for each site using the Hourly Metrics tool within AMT. These files contain informative acoustical metrics including: hourly median exceedance levels, natural ambient sound level (Lnat), daytime and nighttime exceedance levels , daytime and nighttime ambient sound levels, hourly mean and median noise free intervals, and hourly 'contour' data (changes in SPL by the hour at each 1/3 octave frequency band). The metrics files also report detailed measures by source ID including average event count, average event duration, and percent time audible by the hour.

Software Used

Acoustic Monitoring Toolbox version 1.0.5591 (NPS 2008, Fort Collins, CO).
Sound Pressure Level Annotation Tool (SPLAT)
Hourly Metrics tool

Python 3.5.1 |Anaconda 4.0.0 (64-bit)| (default, Feb 16 2016, 09:49:46) [MSC v.1900 64 bit (AMD64)] on win32

soundDB kernel environment developed by the NPS for acoustical analysis
publicly available at: https://github.com/gjoseph92/soundDB

derivedDataFunctions.py script written by Davyd Betchkal, NPS, revised June 2017

Metric Derivation

1. Events per day

One aircraft "event" is defined as an aircraft sound signature measured from when it enters audibility to when it fades out of audibility. "Event" does not necessarily equate to an individual aircraft. It is possible that the same aircraft passed over a single recording device multiple times, or that the same aircraft was captured at two recording devices at different times or distances. Our system set up does not allow for the discrimination of individual aircraft. For our purposes, each noise event (i.e. each time an aircraft can be heard) is considered a single disturbance.

Using Python 3.5.1 and the derivedDataFunctions.py script, we extracted the median events per day and range of events per day from site daily percent audibility files.
Example python code: *[(entry.site, quantile_eventsPerDay(dailypa, q, source = "air")) for entry, dailypa in soundDB.dailypa(ds, site=ds.dailypa.values("site"))]*

2. Lnat

The median sound pressure level that exists in the absence of human noise. Calculated as the exceedance value Lx, where x = 100*((1+PA)/2) and PA = percentage of time that aircraft are audible. This was extracted from METRICS files using Python v. 3.5.1 and thederivedDataFunctions.py script.
Example python code: *MedLnat = [(entry.site, Lnat(metrics, season="Summer", weight = "A")) for entry, metrics in soundDB.metrics(ds, site=ds.metrics.values("site"))]*

The range of Lnat was extracted from METRICS files manually as the lowest and highest median Lnat at each site.

3. Lmax

The maximum one-second Sound Pressure Level exerted by an aircraft.

In an SRCID file this is equivalent to MaxSPL. Using R and thedplyr package, we summarized the median and range MaxSPL at each site (i) across aircraft types and (ii) by different types of aircraft.

R Citations

R version 3.2.4 Revised

R Core Team. 2016. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Hadley Wickham and Romain Francois. 2016. dplyr: A Grammar of Data Manipulation. R packa ge version 0.5.0. https://CRAN.R-project.org/package=dplyr

Hadley Wickham. 2017. tidyr: Easily Tidy Data with 'spread()' and 'gather()' Functions. R packa ge version 0.6.1. https://CRAN.R-project.org/package=tidyr

National Park Service Citations

National Park Service (NPS). 2008. Acoustic Monitoring Toolbox v. 1.0.5591.U.S. Department of the Interior. Fort Collins, Colorado.

National Park Service (NPS). 2010. AUDIO2NVSPL: Audio to NVSPL Converter v. 1.5378.U.S. Department of the Interior. Fort Collins, Colorado.

National Park Service (NPS). 2013. Acoustic Monitoring: Training Manual. U.S. Department of the Interior, National Park Service, Natural Sounds and Night Skies Division, Fort Collins, Colorado.

Figures

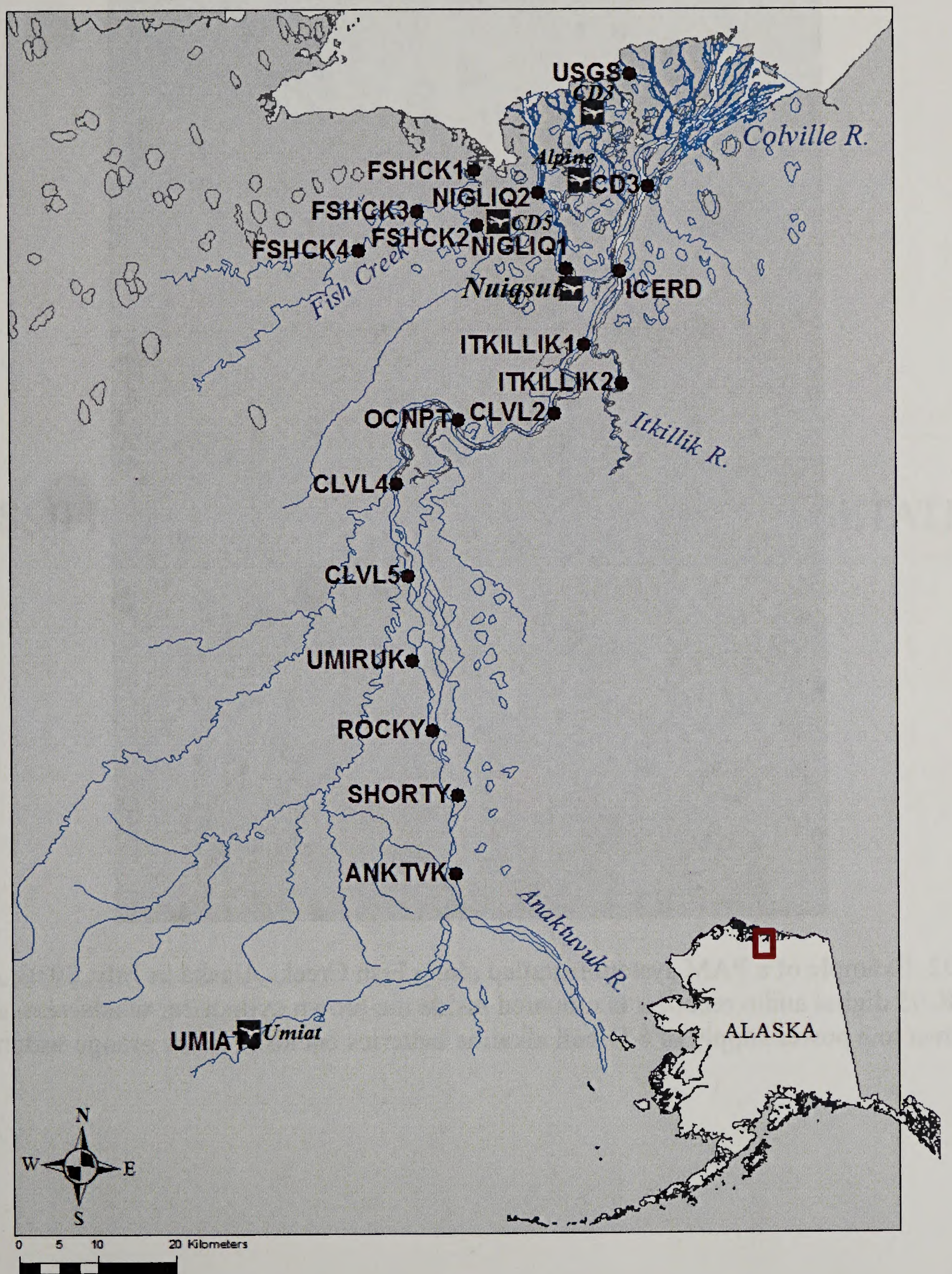

Figure D1. Map showing locations of study sites where PAM systems were deployed during summer 2016 in NPR-A and the vicinity of Nuiqsut. Aircraft symbols indicate locations of airstrips.

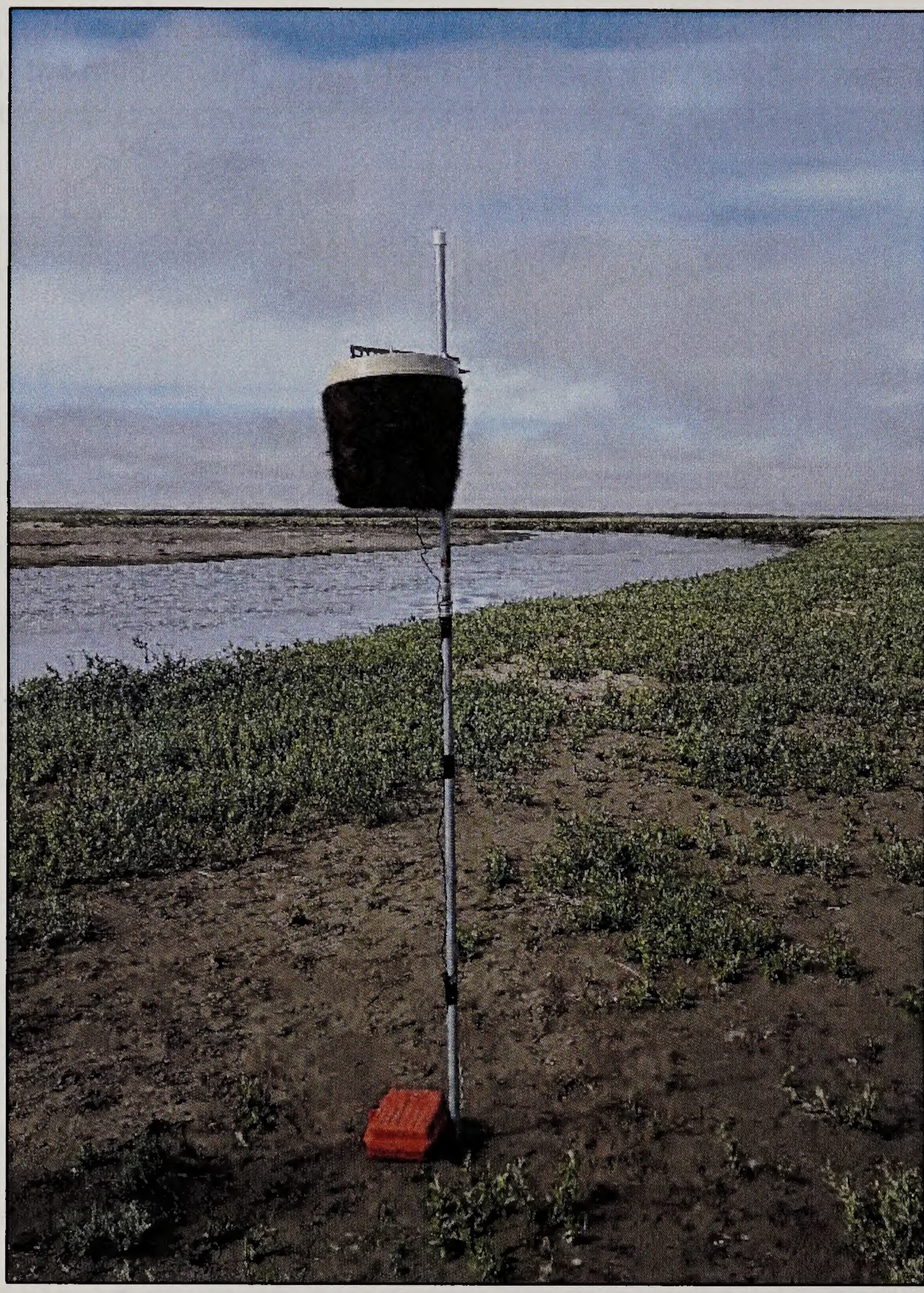

Figure D2. Example of a PAM system installed along Fish Creek, Alaska in July, 2016. A Roland R-05 digital audio recorder is mounted inside the brown cylindrical windscreen and wired down to a power supply of 8 D-cell alkaline batteries enclosed in the orange waterproof case.

APPENDIX D

CLASSIFICATION AND DESCRIPTION OF VEGETATION AND WILDLIFE HABITAT TYPES

APPENDIX D

CLASSIFICATION AND DESCRIPTION OF VEGETATION AND WILDLIFE HABITAT TYPES

Appendix D Contains Excerpts From the Following Sources	
Jorgenson, M.T., J.E. Roth, M. Emers, S.F. Schlenter, D.K, Swanson, E.R. Pullman, J.S. Mitchell, A.A. Stickney. 2003. An Ecological Land Survey in the Northeast Planning Area of the National Petroleum Reserve- Alaska, 2002. Prepared by ABR, Inc.- Environmental Research & Services (ABR, Inc.). Prepared for ConocoPhillips Alaska, Inc. and Anadarko Petroleum Coporation.	Table 7: Classification and Description of Vegetation Classes in the Northeastern Planning Area of the NPRA, 2002
Johnson, C.B., A.M. Wildman, J.P. Parrett, J.R. Rose, T. Obritschkewitsch, and P.E. Seiser. 2013. Avian Studies for the Alpine Satellite Development Project, 2012. Tenth Annual Report. Prepared by ABR, Inc. and Anadarko Petroleum Corporation.	Appendix B: Classification and Descriptions of Wildlife Habitat Types Found in the Colville Delta or NE NPRA Study Areas, Alaska, 2012.

Classification and Description of Vegetation Types

Table 7. Classification and description of vegetation classes in the Northeastern Planning Area of the NPRA, 2002.

Class	Description
Barrens	Nonvegetated flats on river bars, sand dunes, tidal flats, and recently drained lake bottoms that are recently exposed or too unstable to support more than a few pioneering plants (<5% cover). Typical species include *Salix alaxensis, Festuca rubra, Deschampsia caespitosa, Juncus arcticus, Stellaria humifusa,* and *Equisetum arvense.* Riverine Barrens include river flats and bars, commonly along Fish and Judy Creeks. These areas are flooded seasonally and underlain by sand. Toward the coast, sediments are increasingly saline and tidally affected barrens are colonized by salt-tolerant species.
Partially Vegetated	Riverbanks, upland sand dunes, and shallow lake basins that have 5–30% vegetative cover. Colonizers include *Deschampsia caespitosa, Salix alaxensis, Juncus arcticus, Chrysanthemum bipinnatum, Stellaria humifusa, Elymus arenarius mollis, Equisetum arvense* and *Trisetum spicatum.*
Moist Sedge–Shrub Tundra	Lowland sites on moderately well-drained flats and gentle slopes within Thaw Basins, Alluvial–Marine, and Inactive Eolian Sand Deposits, and Riverine Inactive Overbank Deposits, frequently associated with high-centered, and mixed high- and low-centered polygons. Vegetation is co-dominated by sedges (e.g. *Carex bigelowii, C. aquatilis, Eriophorum angustifolium),* and dwarf or low shrubs including *Dryas integrifolia* and *Salix reticulata.* Other common vascular species include *Salix lanata richardsonii, S. planifolia pulchra, Equisetum variegatum, Arctagrostis latifolia,* and *Cassiope tetragona.* Important non-vascular species include *Tomentypnum nitens, Hylocomium splendens, Sanionia uncinata,* and *Dicranum* sp. This class can be confused with Dryas Tundra on drier sites where *Dryas integrifolia* is dominant and Tussock Tundra where *Eriophorum vaginatum* is dominant. Soils are saturated at intermediate depths (> 15 cm) but generally are free of surface water during summer; some sites may be inundated briefly during break-up.
Tussock Tundra	The tussock-forming sedge *Eriophorum vaginatum* dominates the vegetation. On somewhat acidic soils associated species include *Ledum decumbens, Vaccinium vitis-idaea, Salix planifolia pulchra, Betula nana, Salix phlebophylla, Dicranum* sp., and *Hylocomium splendens.* On circumneutral soils *Dryas integrifolia, Salix reticulata, Carex bigelowii,* and *Tomentypnum nitens* are more common though there are many species in common among the two tussock communities and Moist Sedge–Shrub Tundra. Found assoeiated with high-centered, and mixed high- and low-centered polygons on broad slopes of Alluvial–Marine, Inactive Eolian Sand, and Old Alluvial Terrace Deposits and within Ice-rich Thaw Basins. Water generally is absent from the active layer during midsummer.
Common Marestail	In shallow coastal ponds, pond margins, and at the edges of slow moving streams. *Hippuris vulgaris* is the dominant species, *Arctophila fulva, Potamogeton* sp., *Carex subspathacea,* and *Calliergon* sp. are common associates. This class was not mapped.
Fresh Grass Marsh	Shallow lakes within Ice-Poor Thaw Basins and river ox-bows, shallow margins of large lakes, and shallow water of slow-moving headwater streams dominated by *Arctophila fulva.* Water depths generally are < 1.0m. *Hippuris vulgaris, Limprichtia revolvens,* and *Carex aquatilis* may be present in water < 0.5m .
Fresh Sedge Marsh	Permanently flooded shallow water within Thaw Basins, shallow margins of large lakes, and shallow water of slow-moving headwater streams dominated by *Carex aquatilis.* Often found as a fringe between deeper water with *Arctophila fulva* and the lake shore, *Carex aquatilis* also may form a monoculture within shallow (< 0.5m) waterbodies. Associated species include *Scorpidium scorpioides* and *Eriophorum angustifolium.* Polygon development is minimal though disjunct polygon rims may be present.
Wet Sedge Meadow Tundra	Low-lying, poorly drained areas with vegetation dominated by *Carex aquatilis, Eriophorum angustifolium,* and mosses. Associated with nonpatterned ground, low-centered, or disjunct polygons in Thaw Basins, Alluvial–Marine, Old Alluvial Terrace, and Inactive Overbank Deposits. This class is also found in water tracks and swales where willows may be co-dominant. Associated species include *E. russeolum, C. chordorrhiza, C. saxatilis, Salix lanata richardsonii, S. planifolia pulchra,* and *Pedicularis sudetica.* Frequently occurring mosses include *Scorpidium scorpioides, Limprichtia revolvens, Drepanocladus* spp., and *Campylium stellatum.* When polygons are present the rim vegetation is similar to Moist Sedge–Shrub Tundra. The tundra surface generally is flooded during early summer (depth < 0.3m) and water remains close to the surface throughout the growing season. Soils usually have a moderately thick organic layer over silt loam or sandy loam.

Table 7. (Continued).

Class	Description
Salt-killed Wet Meadow	Coastal areas where saltwater intrusions from storm surges have killed much of the original terrestrial vegetation and where salt-tolerant plants are actively colonizing. Colonizing plants include *Puccinellia andersonii, Dupontia fisheri, Braya purpurascens, B. pilosa, Cochlearia officinalis, Stellaria humifusa, Cerastium beeringianum,* and *Salix ovalifolia.* This class typically occurs either on low-lying areas that originally supported Wet Sedge Meadow Tundra and Basin Wetland Complexes, or less commonly, along drier coastal bluffs that originally supported Moist Sedge–Shrub Meadow Tundra. Salt-killed Wet Meadow differs from Halophytic Sedge Wet Meadow in having abundant litter from dead tundra vegetation, a surface horizon of organic soil, and salt-tolerant colonizers.
Halophytic Sedge Wet Meadow	Coastal areas with wet, saline soils typically dominated by the sedges *Carex subspathacea* and *C. ursina.* Primarily found on Inactive Tidal Flat Deposits and Delta Thaw Basins on nonpatterned ground or low-centered polygons, associated species often include *Puccinellia phryganodes, Salix ovalifolia, Calamagrostis deschampsioides, Cochlearia officinalis, Stellaria humifusa,* and *Sedum rosea.*
Dryas Dwarf Shrub Tundra	Dry, upland, sandy slopes, crests, and well-drained river terraces dominated by *Dryas integrifolia.* Most commonly associated with Inactive Eolian Sand Deposits and small dunes, Dryas Dwarf Shrub Tundra also is found on nonpatterned ground and high-centered polygons on Pingos, Inactive Overbank, and Alluvial–Marine Deposits. Inactive dune sites are strongly dominated by *Dryas* and occasionally co-dominated by lichens, associated species include *Salix glauca, S. reticulata, Arctostaphylos alpina, Arctagrostis latifolia, Thamnolia vermicularis,* and *Cetraria cuculata.* Riverine sites may have co-dominant species such as *Equisetum variegatum* and *Salix reticulata,* with *S. lanata richardsonii, Arctostaphylos rubra, Oxytropis deflexa, Tomentypnum nitens,* and *Thamnolia vermicularis* as associated species. Sedges (e.g. *Carex scirpoidea*) may be present on moist sites but are never co-dominant. Soils are sandy, well to somewhat excessively drained, and thaw depths often exceed 1.0m.
Cassiope Dwarf Shrub Tundra	Old dunes and banks on Inactive Eolian Sand, Alluvial–Marine Deposits, and Ice-rich Thaw Basins dominated by *Cassiope tetragona.* Compared with Dryas Dwarf Shrub Tundra, with which this class shares some species, Cassiope Dwarf Shrub Tundra is less well drained, has shallower thaw depths, and can occur on sandy or loamy soils. *Cassiope* dominated sites typically are very species rich, common associated species include *Dryas integrifolia, S. phlebophylla, Salix reticulata, Vaccinium vitis-idaea, Carex bigelowii, Hierochloe alpina,* and *Arctagrostis latifolia.* Cryptogams present include crustose lichens, *Hylocomium splendens, Dicranum* sp., *Tomentypnum nitens,* and *Rhytidium rugosum.* All sites have a wide variety of forbs.
Halophytic Willow Dwarf Shrub Tundra	Coastal areas with moist to wet, saline or slightly saline soils typically dominated by *Salix ovalifolia* or co-dominated by *S. ovalifolia* and halophytic graminoids. Primarily found on Inactive Tidal Flats, Delta Overbank Deposits, and Delta Thaw Basins on nonpatterned ground or low-centered polygons. Associated species often include *Carex subspathacea, C. aquatilis, C. glareosa, Calamagrostis deschampsioides, Dupontia fisheri, Drepanocladus* sp., and *Thamnolia vermicularis.*
Open and Closed Low Willow Shrub	Riverine, lowland or upland communities dominated by low willows (0.2– 1.5m) with an open (25–75% cover) or closed (>75%) canopy. Riverine deposits typically are dominated by *Salix lanata richardsonii* (sometimes co-dominant with *S. planifolia pulchra*), with *Carex aquatilis, Equisetum arvense, E. variegatum, Arctagrostis latifolia,* and *Tomentypnum nitens.* Lowland willow shrub is found primarily on high-centered polygons or nonpatterned ground on Abandoned Floodplains, within Thaw Basins, and on banks or water tracks of Alluvial–Marine Deposits. Lowland communities are dominated by *S. planifolia pulchra,* with *C. aquatilis, S. reticulata, C. bigelowii, Pyrola grandiflora, Dicranum* sp., *Aulacomnium turgidum, A. palustre,* and *Hylocomium splendens.* Upland communities, dominated by *Salix glauca,* are found on small dunes of Eolian Inactive Sand Deposits. Associated species include *S. alaxensis, Arctostaphylos rubra, Dryas integrifolia,* and *Oxytropis nigrescens.*
Open Low Mesic Shrub Birch–Ericaceous Shrub	More typical of areas in the southern NPRA, this class infrequently is found on banks, or high-centered polygons on Alluvial–Marine Deposits. *Betula nana* is dominant with *Salix planifolia pulchra, S. glauca, S. reticulata, Arctostaphylos rubra, Dryas integrifolia, Vaccinium vitis-idaea, Pyrola grandiflora, Hylocomium splendens, Aulacomnium palustre, Dicranum* sp., and *Pleurozium schreberi* as associates. This class was not mapped.

Table 7. (Continued).

Class	Description
Open and Closed Tall Willow Shrub	Active Eolian Sand and Riverine Deposits dominated by *Salix alaxensis*. Willows often are > 1.5m tall with an open (25–75% cover) or closed (>75%) canopy. Soils are very well-drained, sandy, and frequently disturbed by flooding or strong winds. Understory species on riverine deposits include *Equisetum arvense, Chrysanthemum bipinnatum, Festuca rubra, Aster sibiricus,* and *Gentiana propinqua*. Upland dune associates include S. *glauca, Arctostaphylos rubra, Astragalus alpinus, Castilleja caudata, Festuca rubra,* and *Chrysanthemum bipinnatum.*
Water	Permanently flooded, non-vegetated waterbodies. Included in this class are non-vegetated Thaw Lakes, Headwater Streams, Lower Perennial Rivers, Riverine Lakes, and Beaded Streams. Areas mapped as water may include some partially vegetated waterbodies where vegetation was submerged and therefore not discernable on the aerial photography.
Young Basin Wetland Complex (ice-poor)	Young Basin Wetland Complexes occur in portions of recently drained lake basins and are characterized by a complex mosaic of open water, Fresh Sedge and Grass Marshes, Wet Sedge Meadow, and Moist Sedge–Shrub Tundra in patches too small (< 0.5 ha) to map individually. Young basins are distinguished from older basins because they have little ground ice development and typically are dominated by more productive vegetation than older basins. Surface forms are nonpatterned ground or disjunct polygons. To be mapped as a complex an area must be at least 2 ha and have at least three vegetation types, with no single type dominant.
Old Basin Wetland Complex (ice-rich)	Similar to Young Basin Wetland Complexes but occurring in portions of less recently drained basins. This type is characterized by vegetation found in association with ice wedge development and aggradation of segregated ice including Wet Sedge Meadow Tundra with low-centered polygons, Moist Sedge–Shrub, and Tussock Tundra. Fresh Grass Marshes are absent and Sedge Marsh occurs only in flooded portions of margins. Centers of old basins are uplifted sands and loams with shallow to moderate organic horizons. Complexes mapped in centers typically are Tussock, Moist Sedge–Shrub, and Wet Sedge Meadow Tundra. Margins of old basins are wetter with many small, discrete ponds. Soils generally have a moderately thick organic layer overlying sand or sandy loam, vegetation in margins typically is Moist Sedge–Shrub Tundra, Wet Sedge Meadow, Fresh Sedge Marsh, and Water. Complexes are comprised of at least three vegetation types, with no single type dominant. Minimum size for complexes is 2 ha.
Riverine Complex	Permanently flooded channels and narrow bands or patches of vegetation too small to be mapped separately. The variety of vegetation reflects the degree and regularity of flooding. Vegetation classes include Water, Barren or Partially Vegetated gravel bars, Fresh Sedge or Grass Marsh, Wet Sedge Meadow, Moist Sedge–Shrub Tundra, or Low Willow Shrub. Rivers generally experience peak flooding during spring breakup and lowest water levels during mid-summer.
Deep Polygon Complex	Mosaic of vegetation on inactive and abandoned floodplains where low-centered polygons have particularly deep (>0.5 m) centers formed by thaw settlement of ice-rich soils. Permanently flooded nonvegetated polygon centers are fringed by Fresh Grass or Sedge Marsh. Broad, low, rims of Wet Sedge Meadow or Moist Sedge–Shrub Tundra separate the centers. While water forms a substantial portion of this class, no single vegetation type or water is dominant.
Dune Complex	Complex formed on inactive sand dunes on meander floodplains. A series of narrow swale and ridge features develop in parallel with river flow that are too small to map separately. Vegetation in moist to wet swales typically is Low Willow Shrub, Wet Sedge Meadow Tundra, or Fresh Sedge Marsh, while dry to moist sandy, dune ridges commonly are Dryas Dwarf Shrub Tundra or Low Willow Shrub.

Table 7. (Continued)

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Classification and Description of

Wildlife Habitat Types

Appendix B. Classification and descriptions of wildlife habitat types found in the Colville Delta or NE NPRA study areas, Alaska, 2012. Species associations of some habitats vary between the Colville Delta and the NE NPRA study areas.

Habitat Class	Description
Open Nearshore Water (Estuarine Subtidal)	Shallow estuaries, lagoons, and embayments along the coast of the Beaufort Sea. Winds, tides, river discharge, and icing create dynamic changes in physical and chemical characteristics. Tidal range normally is small (< 0.2 m), but storm surges produced by winds may raise sea level as much as 2–3 m. Bottom sediments are mostly unconsolidated mud. Winter freezing generally begins in late September and is completed by late November. An important habitat for some species of waterfowl for molting during spring and fall staging.
Brackish Water (Tidal Ponds)	Coastal ponds and lakes that are flooded periodically with saltwater during storm surges. Salinity levels often are increased by subsequent evaporation of impounded saline water. Sediments may contain peat, reflecting a freshwater/terrestrial origin, but this peat is mixed with deposited silt and clay.
Tapped Lake with Low-water Connection	Waterbodies that have been partially drained by erosion of banks by adjacent river channels and are connected to rivers by distinct, permanently flooded channels. The water typically is brackish and the lakes are subject to flooding every year. Because water levels have dropped, the lakes generally have broad flat shorelines with silty clay sediments. Salt-marsh vegetation is common along the shorelines. Deeper lakes in this habitat do not freeze to the bottom during winter. Sediments are fine-grained silt and clay with some sand. These lakes form important over-wintering habitat for fish.
Tapped Lake with High-water Connection	Similar to Tapped Lake with Low-water Connection except that the connecting channels are dry during low water and the lakes are connected only during flooding events. Water tends to be fresh. Small deltaic fans are common near the connecting channel due to deposition during seasonal flooding. These lakes form important fish habitat.
Salt Marsh	On the Beaufort Sea coast, arctic Salt Marshes generally occur in small, widely dispersed patches, most frequently on fairly stable tidal flats associated with river deltas. The surface is flooded irregularly by brackish or marine water during high tides, storm surges, and river flooding events. Salt Marshes typically include a complex assemblage of small brackish ponds and Halophytic Sedge or Grass Wet Meadows. Moist Halophytic Dwarf Shrub and small barren areas also may occur in patches too small to map separately. Dominant plant species usually include *Carex subspathacea, C. ursina, C. ramenskii, Puccinellia phryganodes, Dupontia fisheri, P. andersonii, Salix ovalifolia, Cochlearia officinalis, Stellaria humifusa,* and *Sedum rosea*. Salt Marsh is important habitat for brood-rearing and molting waterfowl.
Moist Halophytic Dwarf Shrub	Tidal flats and regularly flooded riverbars of tidal rivers with vegetation dominated by dwarf willow and graminoids. Tide flat communities have brackish, loamy (with variable organic horizons), saturated soils, with ground water depths ~ 25 cm and active layer depths ~50 cm. Vegetation is dominated by *Salix ovalifolia, Carex subspathacea,* and *Calamagrostis deschampsioides*. On sandy sites *Elymus arenarius mollis* is a co-dominant. On active tidal river depostis, soils are loamy, less brackish, and vegetation is dominated by *Salix ovalifolia* with *Carex aquatilis* and *Dupontia fisheri*.

Appendix B. (Continued).

Habitat Class	Description
Dry Halophytic Meadow	Somewhat poorly vegetated, well-drained meadows on regularly inundated tidal flats and riverbars of tidal rivers, characterized by the presence of *Elymus arenarius mollis*. Soils are brackish sands with little organic material and deep active layers. Commonly associated species include *Salix ovalifolia, Sedum rosea, Stellaria humifusa*, (on tide flats) and *Deschampsia caespitosa* (on tidal river deposits).
Tidal Flat Barrens	Areas of nearly flat, barren mud or sand that are periodically inundated by tidal waters. Tidal Flat Barrens occur on the seaward margins of deltaic estuaries, leeward portions of bays and inlets, and at mouths of rivers. Tidal Flat Barrens frequently are associated with lagoons and estuaries and may vary widely in actual salinity levels. Tidal Flat Barrens are considered separately from other barren habitats because of their importance to estuarine and marine invertebrates and shorebirds.
Salt-killed Tundra	Coastal areas where saltwater intrusions from storm surges have killed much of the original terrestrial vegetation and are being colonized by salt-tolerant plants. Colonizing plants include *Puccinellia andersonii, Dupontia fisheri, Braya purpurascens, B. pilosa, Cochlearia officinalis, Stellaria humifusa, Cerastium beeringianum,* and *Salix ovalifolia.* This habitat typically occurs either on low-lying areas that originally supported Patterned Wet Meadows and Basin Wetland Complexes or, less commonly, along drier coastal bluffs that originally supported Moist Sedge–Shrub Meadow and Dry Dwarf Shrub. Salt-killed Tundra differs from Salt Marshes in having abundant litter from dead tundra vegetation, a surface horizon of organic soil, and salt-tolerant colonizers.
Deep Open Water without Islands	Deep (≥1.5 m) waterbodies range in size from small ponds in ice-wedge polygons to large open lakes. Most have resulted from thawing of ice-rich sediments, although some are associated with old river channels. They do not freeze to the bottom during winter and usually are not connected to rivers. Sediments are fine-grained silt in centers with sandy margins. Deep Open Waters without Islands are differentiated from those with islands because of the lack of nest sites for waterbirds that prefer islands.
Deep Open Water with Islands or Polygonized Margins	Similar to above except that they have islands or complex shorelines formed by thermal erosion of low-center polygons. The complex shorelines and islands are important features of nesting habitat for many species of waterbirds.
Shallow Open Water without Islands	Ponds and small lakes <1.5 m deep with emergent vegetation covering <5% of the waterbody's surface. Due to the shallow depth, water freezes to the bottom during winter and thaws by early to mid-June. Maximal summer temperatures are higher than those in deep water. Sediments are loamy to sandy.
Shallow Open Water with Islands or Polygonized Margins	Shallow lakes and ponds with islands or complex low-center polygon shorelines, otherwise similar to Shallow Open Water without Islands. Distinguished from Shallow Open Water without Islands because shoreline complexity appears to be an important feature of nesting habitat for many species of waterbirds.
River or Stream	All permanently flooded channels large enough to be mapped as separate units. Rivers generally experience peak flooding during spring breakup and lowest water levels during mid-summer. The distributaries of Fish Creek are slightly saline, whereas other streams are non-saline.

Appendix B. (Continued).

Habitat Class	Description
Sedge Marsh	Permanently flooded waterbodies dominated by *Carex aquatilis*. Typically, emergent sedges occur in water ≤0.5 m deep. Water and bottom sediments of this shallow habitat freeze completely during winter, but the ice melts in early June. The sediments generally consist of a peat layer (0.2–0.5 m deep) overlying loam or sand.
Deep Polygon Complex	A habitat associated with inactive and abandoned floodplains and deltas in which thermokarst of ice-rich soil has produced deep (>0.5 m), permanently flooded polygon centers. Emergent vegetation, mostly *Carex aquatilis,* usually is found around the margins of the polygon centers. Occasionally, centers will have the emergent grass *Arctophila fulva*. Polygon rims are moderately well drained and dominated by sedges and dwarf shrubs, including *Carex aquatilis, Eriophorum angustifolium, C. bigelowii, Dryas integrifolia, Salix reticulata,* and *S. ovalifolia*.
Grass Marsh	Ponds and lake margins with the emergent grass *Arctophila fulva*. Due to shallow water depths (<1 m), the water freezes to the bottom in the winter, and thaws by early June. *Arctophila fulva* stem densities and annual productivity can vary widely among sites. Sediments generally lack peat. This type usually occurs as an early successional stage in recently drained lake basins and is more productive than Sedge Marsh. This habitat tends to have abundant invertebrates and is important to many waterbirds.
Young Basin Wetland Complex (Ice-poor)	Complex habitat found in recently drained lake basins and characterized by a mosaic of open water, Sedge and Grass Marshes, Nonpatterned Wet Meadows, and Moist Sedge–Shrub Meadows in patches too small (<0.5 ha) to map individually. During spring breakup, basins may be entirely inundated, though water levels recede by early summer. Basins often have distinct banks marking the location of old shorelines, but these boundaries may be indistinct due to the coalescence of thaw basins and the presence of several thaw lake stages. Soils generally are loamy to sandy, moderately to richly organic, and ice-poor. Because there is little segregated ground ice the surface form is nonpatterned ground or disjunct polygons and the margins of waterbodies are indistinct and often interconnected. Ecological communities within young basins appear to be much more productive than are those in older basins: this was the primary rationale for differentiating these two types.
Old Basin Wetland Complex (Ice-rich)	Similar to above but characterized by well-developed low- and high-centered polygons resulting from ice-wedge development and aggradation of segregated ice. Complexes in basin margins generally include Sedge Marsh, Patterned Wet Meadow, Moist Sedge–Shrub Meadows, and small ponds (<0.25 ha). The waterbodies in old basins tend to have smoother, more rectangular shorelines and are not as interconnected as those in more recently drained basins. The vegetation types in basin centers generally include Moist Sedge–Shrub Meadow and Moist Tussock Tundra on high-centered polygons, and Patterned Wet Meadows. Grass Marsh generally is absent. Soils have a moderately thick (0.2–0.5 m) organic layer overlying loam or sand.

Appendix B. (Continued).

Habitat Class	Description
Riverine Complex	Permanently flooded streams and floodplains characterized by a complex mosaic of water, Barrens, Dry Dwarf Shrub, Moist Tall Shrub and Moist Low Shrub, Sedge and Grass Marsh, Nonpatterned and Patterned Wet Meadow, and Moist Sedge–Shrub Meadow in patches too small (<0.5 ha) to map individually. Surface form varies from nonpatterned point bars and meadows to mixed high- and low-centered polygons and small, stabilized dunes. Small ponds tend to have smooth, rectangular shorelines resulting from the coalescing of low centered polygons. During spring flooding these areas may be entirely inundated, following breakup water levels gradually recede.
Dune Complex	Complex formed from the action of irregular flooding on inactive sand dunes, most commonly on river point bars. A series of narrow swale and ridge features develop in parallel with river flow that are too small to map separately. Swales are moist or saturated while ridges are moist to dry. Habitat classes in swales typically are Moist Low Shrub, Nonpatterned Wet Meadow, or Sedge Marsh, while ridges commonly are Dry Dwarf Shrub or Moist Low Shrub.
Nonpatterned Wet Meadow	Sedge-dominated meadows that occur within recently drained lake basins, as narrow margins of receding waterbodies, or along edges of small stream channels in areas that have not yet undergone extensive ice-wedge polygonization. Disjunct polygon rims and strang cover <5% of the ground surface. The surface generally is flooded during early summer (depth <0.3 m) and drains later, but water remains close to the surface throughout the growing season. The uninterrupted movement of water (and dissolved nutrients) in nonpatterned ground results in more robust growth of sedges than occurs in polygonized habitats. Usually dominated by *Carex aquatilis* and *Eriophorum angustifolium*, although other sedges may be present. Near the coast, the grass *Dupontia fisheri* may be present. Low and dwarf willows (*Salix lanata richardsonii, S. reticulata, S. planifolia pulchra*) occasionally are present. Soils generally have a moderately thick (10–30 cm) organic horizon overlying loam or sand.
Patterned Wet Meadow	Lowland areas with low-centered polygons or strang within drained lake basins, level floodplains, and flats and water tracks on terraces. Polygon centers are flooded in spring and water remains close to the surface throughout the growing season. Polygon rims or strang interrupt surface and groundwater flow, so only interconnected polygon troughs receive downslope flow and dissolved nutrients; in contrast, the input of water to polygon centers is limited to precipitation. As a result, vegetation growth typically is more robust in polygon troughs than in centers. Vegetation is dominated by sedges, usually *Carex aquatilis* and *Eriophorum angustifolium*, although other sedges may be present including *C. rotundata, C. saxatilis, C. membranacea, C. chordorrhiza*, and *E. russeolum*. On polygon rims, willows (e.g., *Salix lanata richardsonii, S. reticulata, S. planifolia pulchra*) and the dwarf shrubs *Dryas integrifolia* and *Cassiope tetragona* may be abundant along with other species typical of moist tundra.
Moist Sedge–Shrub Meadow	High-centered, low-relief polygons and mixed high- and low-centered polygons on gentle slopes of lowland, riverine, drained basin, and solifluction deposits. Soils are saturated at intermediate depths (>0.15 m) but generally are free of surface water during summer. Vegetation is dominated by *Dryas integrifolia*, and *Carex bigelowii*. Other common species include *C. aquatilis, Eriophorum angustifolium, Salix reticulata, S. lanata richardsonii,* and the moss *Tomentypnum nitens*. The active layer is relatively shallow and the organic horizon is moderate (0.1–0.2 m).

Appendix B. (Continued).

Habitat Class	Description
Moist Tussock Tundra	Gentle slopes and ridges of coastal deposits and terraces, pingos, and the uplifted centers of older drained lake basins. Vegetation is dominated by tussock-forming plants, most commonly *Eriophorum vaginatum.* High-centered polygons of low or high relief are associated with this habitat. Soils are loamy to sandy, somewhat well-drained, acidic to circumneutral, with moderately thick (0.1–0.3 m) organic horizons and shallow (<0.4 m) active layer depths. On acidic sites, associated species include *Ledum decumbens, Betula nana, Salix planifolia pulchra, Cassiope tetragona* and *Vaccinium vitis-idaea.* On circumneutral sites common species include *Dryas integrifolia, S. reticulata, Carex bigelowii,* and lichens. Mosses are common at most sites.
Moist Tall Shrub	Most commonly found on actively flooded banks and bars of meander and tidal rivers dominated by tall (> 1.5 m) shrubs. Sites are nonpatterned and subject to variable flooding frequency, soils are well-drained, alkaline to circumneutral, and lack organic material. Vegetation is defined by an open canopy of *Salix alaxensis.* Understory species include *Equisetum arvense, Gentiana propinqua, Chrysanthemum bipinnatum, Festuca rubra* and *Aster sibiricus.* Moist Tall Shrub occasionally occurs on protected lowland sites where the dominant species may be *Salix* spp.or *Alnus crispa.*
Moist Low Shrub	Any community on moist soils dominated by willows < 1.5m tall. Upland sites are well-drained sands and loams characterized by *Salix glauca* (or infrequently, *Betula nana*), *Dryas integrifolia*, and *Arctostaphylos rubra.* Recently drained basins are somewhat poorly drained loams with moderate organic horizons dominated by either *S. lanata richardsonii* or *S. planifolia pulchra* with *Eriophorum angustifolium* and *Carex aquatilis.* Riverbank deposits also are dominated by either *S. lanata richardsonii* or *S. planifolia pulchra*, but with *Equisetum arvense*, *Arctagrostis latifolia*, or *Petasites frigidus.* Somewhat poorly-drained lowland flats and lower slopes have the greatest organic horizon development and are dominated by *S. planifolia pulchra.* Associated species are similar to those in drained basin communities. Thaw depths are deepest in riverine and upland communities and shallowest in lowland areas.
Moist Dwarf Shrub	Well-drained upland slopes and banks, and the margins of drained lake basins dominated by *Cassiope tetragona.* Soils are well-drained, loamy to sandy and circumneutral to acidic. Vegetation is species rich, associated species include *Dryas integrifolia, Salix phlebophylla, Vaccinium vitis-idaea, Carex bigelowii, Arctagrostis latifolia, Hierochloe alpina, Pyrola grandiflora,* and *Saussurea angustifolia.* Lichens and mosses also are common.
Dry Tall Shrub	Crests of active sand dunes with vegetation dominated by the tall willow *Salix alaxensis.* Soils are sandy, excessively drained, alkaline to circumneutral, with deep active layers (>1 m) and no surface organic horizons. The shrub canopy usually is open with dominant shrubs >1m tall. Other common species include *Chrysanthemum bipinnatum, Festuca rubra*, and *Equisetum arvense.*

Appendix B. (Continued).

Habitat Class	Description
Dry Dwarf Shrub	Well-drained riverbank deposits and windswept, upper slopes and ridges dominated by the dwarf shrub *Dryas integrifolia*. Soils are sandy to loamy, alkaline to circumneutral, with deep active layers. Upland sites are lacking in organics, and in riverine sites organic accumulation is shallow. Riverbank communities have *Salix reticulata, Carex bigelowii, Arctagrostis latifolia, Equisetum variegatum, Oxytropis deflexa, Arctostaphylos rubra,* and lichens as common associates, while upland sites have *S. reticulata, S. glauca, S. arctica, C. bigelowii, Arctostaphylos alpina, Arctagrostis latifolia*, and lichens.
Barrens (Riverine, Eolian, or Lacustrine)	Includes barren and partially vegetated (<30% plant cover) areas related to riverine, eolian, or thaw basin processes. Riverine Barrens on river flats and bars are underlain by moist sands and are flooded seasonally. Early colonizers are *Deschampsia caespitosa, Poa hartzii, Festuca rubra, Salix alaxensis*, and *Equisetum arvense.* Eolian Barrens are active sand dunes that are too unstable to support more than a few pioneering plants (<5% cover). Typical species include *Salix alaxensis, Festuca rubra,* and *Chrysanthemum bipinnatum.* Lacustrine Barrens occur within recently drained lakes and ponds. These areas may be flooded seasonally or can be well drained. Typical colonizers are forbs, graminoids, and mosses including *Carex aquatilis, Dupontia fisheri, Scorpidium scorpioides*, and *Calliergon* sp. on wet sites and *Poa* spp., *Festuca rubra, Deschampsia caespitosa, Stellaria humifusa, Senecio congestus,* and *Salix ovalifolia* on drier sites. Barrens may receive intense use seasonally by caribou as mosquito-relief habitat.
Human Modified (Water, Fill, Peat Road)	A variety of small disturbed areas, including impoundments, gravel fill, and a sewage lagoon at Nuiqsut. Gravel fill is present at Nuiqsut, the Alpine facilities, and at the Helmericks' residence near the mouth of the Colville River.

Cross Reference for

Habitat and Vegetation Types

Cross Reference for Habitat and Vegetation Types	
Vegetation Type	**Habitat Type**
Partially Vegetated	Barrens
Barren	Barrens
Water	Brackish Water
Water	Deep Open Water with Islands or Polygonized Margins
Water	Deep Open Water without Islands
Deep Polygon Complex	Deep Polygon Complex
Dryas Dwarf Shrub Tundra	Dry Dwarf Shrub
Open Tall Willow	Dry Tall Shrub
Dune Complex	Dune Complex
Fresh Grass Marsh	Grass Marsh
Partially Vegetated	Human Modified
Barren	Human Modified
Water	Human Modified
Cassiope Dwarf Shrub Tundra	Moist Dwarf Shrub
Halophytic Willow–Graminoid Dwarf Shrub Tundra	Moist Halophytic Dwarf Shrub
Open Low Willow	Moist Low Shrub
Closed Low Willow	Moist Low Shrub
Open Tall Willow	Moist Low Shrub
Moist Sedge–Shrub Tundra	Moist Sedge-Shrub Meadow
Open Tall Willow	Moist Tall Shrub
Tussock Tundra	Moist Tussock Tundra
Wet Sedge Meadow Tundra	Nonpatterned Wet Meadow
Old Basin Wetland Complex	Old Basin Wetland Complex
Wet Sedge Meadow Tundra	Patterned Wet Meadow
Water	River or Stream
Riverine Complex	Riverine Complex
Salt–killed Wet Meadow	Salt-killed Tundra
Halophytic Grass Wet Meadow, brackish	Salt Marsh
Coastal Complex	Salt Marsh
Fresh Sedge Marsh	Sedge Marsh
Water	Shallow Open Water with Islands or Polygonized Margins
Water	Shallow Open Water without Islands
Water	Tapped Lake with Low-water Connection

APPENDIX E

ESSENTIAL FISH HABITAT

Essential Fish Habitat

Regulatory Background

The 1996 Sustainable Fisheries Act (Public Law 104-297) enacted additional management measures to protect commercially harvested fish species from overfishing. Along with reauthorizing the Magnuson- Stevens Fishery Conservation and Management Act (Public Law 94-265 [Magnuson-Stevens Act), one of those added measures is to describe, identify, and minimize adverse effects to "essential fish habitat." Definitions and rules involving essential fish habitat are in 50 CFR Part 600. The National Marine Fisheries Service implements the requirements of the Magnuson-Stevens Act.

Essential fish habitat definition: "…those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. For the purpose of interpreting the definition of essential fish habitat: 'Waters' include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; 'substrate' includes sediment, hard bottom, structures underlying the waters, and associated biological communities; 'necessary' means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and 'spawning, breeding, feeding, or growth to maturity' covers a species' full life cycle" (50 CFR Part 600.10).

Adverse effect definition: "…any impact that reduces quality and/or quantity of EFH. Adverse effects may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality and/or quantity of EFH. Adverse effects to EFH may result from actions occurring within EFH or outside of EFH and may include site-specific or habitat- wide impacts, including individual, cumulative, or synergistic consequences of actions" (50 CFR Part 600.810).

Federal action requirement: "For any Federal action that may adversely affect EFH, Federal agencies must provide National Marine Fisheries Service with a written assessment of the effects of that action on EFH.… Federal agencies may incorporate an EFH Assessment into documents prepared for other purposes such as…the National

Environmental Policy Act" (50 CFR Part 600.920).

In 1997, the National Marine Fisheries Service issued an interim final rule to implement the essential fish habitat provisions of the Magnuson-Stevens Act (62 FR 66531). This included the clarification that Regional Fishery Management Councils would describe and identify essential fish habitat in fishery management plans. In Alaska, fishery management plans are developed by the North Pacific Fishery Management Council and approved by Secretary of Commerce. In 2002, National Marine Fisheries Service issued a final rule with no substantial changes to the interim rule (67 FR 2343).

Arctic Essential Fish Habitat

Fish species with essential fish habitat designated in and near the NPR-A include all five species of Pacific salmon [chum (*Oncorhynchus keta*), pink (*O. gorbuscha*), Chinook (*O. tshawytscha*), coho (*O. kisutch*), and sockeye (*O. nerka*)], Arctic cod (*Boregogadus saida*), and saffron cod (*Eleginus gracilis*). Of these, only the Pacific salmon occur in and near the project study area. Salmon are managed under the "Fishery Management Plan for the Salmon Fisheries in the EEZ off the Coast of Alaska" (Salmon Fishery Management Plan; North Pacific Fishery Management Council 1990).

All of the salmon species have anadromous life histories that are described broadly in Table 1 according to Mecklenburg et al. (2002). For more detailed information on each species, see Groot and Margolis (1991).

Table 1. Pacific salmon life history characteristics

Species	Spawning habitat	Migration to sea from spawning habitat	Time at sea
Chum salmon	Freshwater	Immediately	3 to 5 years
Pink salmon	Freshwater or intertidal zone	Immediately	18 months
Chinook salmon	Freshwater	3 months to 2 years	1 to 5 years
Coho salmon	Freshwater	1 to 4 years	2 to 3 years
Sockeye salmon	Freshwater (lakes)	1 to 2 years	1 to 4 years

In the northeast Chukchi Sea and western Beaufort Sea, all five species of Pacific salmon have been reported (Craig and Haldorson 1986). However, salmon have a very difficult time establishing sustainable runs in the Arctic, most likely because of marginal

freshwater habitats (Craig 1989a). Pink and chum salmon occur in the greatest numbers. Although the number of actual spawning stocks (versus probable stray runs) is unknown, they are relatively common in the Chukchi Sea and Beaufort Sea (Moss et al. 2009).

Chinook salmon are much more uncommon in the NPR-A and its coastal waters and sockeye and coho salmon are rare. Due to the colder temperatures in the Beaufort Sea, these salmon species are more likely to be present in the northeast Chukchi Sea, although captures anywhere north of Point Hope are most commonly limited to only one or a few individuals (Craig and Haldorson 1986). In 17 years of summer coastal sampling in the Prudhoe Bay region of the Beaufort Sea (1981–1997), only one king salmon and zero sockeye or coho salmon were captured (BLM 2012, Appendix D, p. 66).

The most current essential fish habitat descriptions for salmon in the Arctic are included in amendments 7 and 8 to the Salmon Fishery Management Plan (North Pacific Fishery Management Council 2006), which implemented the preferred alternative from the "Environmental Impact Statement for Essential Fish Habitat Identification and Conservation in Alaska" (National Marine Fisheries Service 2005). This describes essential fish habitat that encompasses all life history stages for all Pacific salmon species as marine waters extending to the outer limit of the U.S. Exclusive Economic Zone, estuarine waters extending to the salinity transition zone, and freshwaters that are identified as being used by salmon in Alaska Department of Fish and Game's "Catalogue of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes" (Alaska Department of Fish and Game 2011), also known as the "Anadromous Waters Catalog." The outer limit of the U.S. Exclusive Economic Zone is 200 nautical miles; for analysis purposes here, the salinity transition zone is considered to be 10 kilometers offshore, as this is typically the greatest extent of the estuarine band that forms along the coast of the Beaufort Sea during the summer (Craig 1984a); and a more recent version of freshwaters documented as being utilized by salmon is available in the current electronic version of the Anadromous Waters Catalog (ADF&G 2017). These essential fish habitat designations for salmon are shown on Map 3.3-5. Table 2 lists the stream and river systems with essential fish habitat in the project study area.

Table 2. Stream and river systems in the GMT2 project area with freshwater essential fish habitat based on the Anadromous Waters Catalog

Stream system	AWC Code	Salmon species utilizing
Colville River	330-00-10700	pink, chum
Fish Creek	330-00-10840	pink, chum, Chinook
Ublutuoch River	330-00-10840-2017	pink, chum, Chinook

Source: Alaska Department of Fish and Game (2017)

Proposed Action and Alternatives

The BLM is undertaking the GMT2 Supplemental Environmental Impact Statement (SEIS) to determine the appropriate management decisions for allowing the applicant to construct and operate an oil production infrastructure in the project study area. The BLM will consider the best management practices, while providing special protections for specific habitats and site-specific resources and uses.

Potential Adverse Effects on Essential Fish Habitat

The potential adverse effects on essential fish habitat from the GMT2 project alternatives would be the same as those described for other fish habitat in Section 4.3.2. No effects on marine or estuarine essential fish habitat would be expected. Potential effects on freshwater essential fish habitat from a variety of oil and gas activities described in detail in Section 4.6.7.2 broadly include altered water quality, physical habitat changes (water quantity, flow patterns, and geomorphology), increased turbidity and sedimentation, and barriers to fish movements. The primary difference among alternatives is the type, amount, and location of impacts that have the potential to affect fish populations. Based on the proximity to and the potential for impacts to waters listed for salmon in the Anadromous Waters Catalog, the greatest potential impacts to freshwater essential fish habitat are expected to occur under Alternatives A and B (primarily due to potential impacts during the open water season from roads), less risk under Alternative C.

Proposed Mitigation Measures

Lease stipulations and best management practices would mitigate potential effects on essential fish habitat. Proper implementation of these protective measures should

ensure that impacts to essential fish habitat are avoided or minimized. The following list summarizes the mitigation measures. These management standards largely address relevant comparable Recommended Conservation Measures identified in "Impacts to Essential Fish Habitat from Non-fishing Activities in Alaska" (National Marine Fisheries Service 2011).

- Best Management Practice A-2: Requires comprehensive waste management plan.
- Best Management Practice A-3: Requires a hazardous materials emergency contingency plan.
- Best Management Practice A-4: Requires a comprehensive spill prevention and response contingency plan.
- Best Management Practice A-5: Establishes refueling setbacks from waterbodies.
- Best Management Practice A-6: Prohibits discharge of reserve-pit fluids.
- Best Management Practice A-7: Prohibits discharge of produced water in upland areas and marine waters.
- Best Management Practice B-1: Prohibits water withdrawals from rivers and streams during winter.
- Best Management Practice B-2: Establishes lake water withdrawal limits and practices to protect fish.
- Best Management Practice C-2: Requires sufficient ground frost and snow cover prior to winter overland moves, contributing to the protection of stream banks and frozen waterbodies.
- Best Management Practice C-3: Establishes winter river and stream crossing guidelines related to protecting runoff patterns, fish passage, and natural channel characteristics, including the requirement that crossings reinforced with additional snow or ice ("bridges") be removed, breached, or slotted before spring breakup.
- Best Management Practice C-4: Establishes winter river and stream crossing guidelines related to avoiding additional freeze-down into fish habitat, including restrictions on traveling up and down streambeds.
- Lease Stipulation D-1: Prohibits exploratory drilling within the floodplain of rivers and streams and within fish-bearing lakes.
- Lease Stipulation D-2: Prohibits construction of permanent or gravel facilities (including pads, roads, and airstrips) for exploratory drilling.
- Best Management Practice E-1: Requires that all roads be designed, constructed, maintained, and operated in a manner that minimizes environmental impacts.
- Lease Stipulation E-2: Prohibits permanent facilities (including pads, roads, airstrips, and pipelines) within 500 feet of fish-bearing waterbodies, except for essential road and pipeline crossings that will be permitted on a case-by-case basis.
- Lease Stipulation E-3: Prohibits causeways, docks, artificial gravel islands, and bottom-founded structures in river mouths or deltas. Requires that the design of any coastal structure ensures free fish passage and doesn't cause significant changes to nearshore oceanographic circulation patterns and water quality characteristics.
- Best Management Practice E-4: Requires that pipelines be designed, constructed,

and operated according to the best available technology for detecting and preventing corrosion that can lead to leaks.

- Best Management Practice E-5: Establishes guidelines to minimize the development footprint, which would minimize the total impervious surface area within individual drainages.
- Best Management Practice E-6: Requires that stream and marsh crossings be designed and constructed to ensure free fish passage, reduce erosion, maintain natural drainage, and minimize effects to natural stream flow.
- Best Management Practice E-8: Establishes gravel mine guidelines for design that will minimize negative effects on fish habitat and for reclamation that will promote potential positive effects on fish habitat.
- Best Management Practice E-14: Requires that stream and river road crossings utilize the most current design tools that will facilitate free fish passage, including a minimal of 3 years of hydrology and fish data to guide decisions.
- Lease Stipulation/Best Management Practice K-1: Establishes setback distances for permanent facilities (including pads, roads, airstrips, and pipelines) of 0.5 mile, 0.75 mile, 1 mile, and, under Alternative B-1 and B-2, 2 miles from many major streams and rivers, except for essential road and pipeline crossings that will be permitted on a case-by-case basis.
- Lease Stipulation/Best Management Practice K-3b: Establishes additional protective measurements for "major coastal waterbodies" regarding exploration and development.

Essential Fish Habitat Finding

No marine or estuarine essential fish habitat impacts are probable based on the scope of the proposed action. The multitude of required operating procedures/best management practices listed above would provide substantial environmental protections that would minimize or avoid effects on freshwater essential fish habitat. Although unavoidable impacts will occur to some freshwater habitat in the project study area, those streams and rivers with freshwater essential fish habitat are much less likely to experience those impacts. For example, all streams and rivers currently considered freshwater essential fish habitat (Table 2 above) are provided an additional safeguard through infrastructure setbacks included in Lease Stipulation/Best Management Practice K-1. Also, since streams and rivers comprising freshwater essential fish habitat are listed within the Anadromous Waters Catalog, they are granted further regulatory protection under the Anadromous Fish Act (AS 16.05.871) which requires additional review and permitting of activities by Alaska Department of Fish and Game. Based on these considerations, oil and gas exploration and development in the NPR-A is assigned the essential fish habitat assessment determination: "May affect, not likely to adversely affect".

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APPENDIX F

OVERVIEW OF NUIQSUT SUBSISTENCE USES

Greater Mooses Tooth 2 Development
Supplemental Environmental Impact Statement
Subsistence

APPENDIX F:
Overview of Nuiqsut Subsistence Uses

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May 16, 2017

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ACRONYMS

ANCSA - Alaska Native Claims Settlement Act

ATV - All terrain vehicle

GMT2 - Greater Mooses Tooth 2

IAI - Impact Assessment, Inc.

ISER - Institute of Social and Economic Research

NSB - North Slope Borough

SRB&A - Stephen R. Braund & Associates

CHAPTER 1: INTRODUCTION

The proposed Greater Mooses Tooth 2 (GMT2) Development is located in the North Slope region, a geographical area that extends north of the Brooks Range in Alaska to the Beaufort Sea. The North Slope environment includes the Brooks Range, Arctic Foothills, and Arctic Coastal Plain eco-regions. The GMT2 Project area is located in the Arctic Coastal Plain, which consist of flat tundra environment with poor drainage and numerous lakes (Gallant et al. 1995). This region is characterized by low mean annual temperatures and precipitation.

At the time of European contact, the North Slope was inhabited by indigenous Iñupiat populations, which were comprised of two primary cultural groups. The Tagiugmiut inhabited coastal areas of the Arctic Coastal Plain and the Nunamiut inhabited the interior including the Brooks Range and Arctic Foothills areas. Iñupiaq is the language spoken by both North Slope cultural groups as well as in other areas of Alaska (including Northwestern Alaska and the Seward Peninsula) and Canada (known as Inuktitut). Coastal Iñupiat (Tagiugmiut) relied primarily on harvests of marine mammals, terrestrial mammals, and fish, while their inland neighbors, the Nunamiut, relied mostly on terrestrial mammals and fish, with caribou comprising the majority of their subsistence harvests.

Iñupiat are still the primary occupants of the North Slope today and continue the hunting and harvesting traditions of their ancestors. Local residents often harvest subsistence resources from specific camps that are situated in locations that provide multiple resource harvest opportunities throughout the year. Harvest activities tend to occur near communities, along rivers and coastlines, or at particularly productive sites where resources are known to occur seasonally. Traditional knowledge concerning the distribution, migration, seasonal variation of animal populations, and other environmental factors (e.g., tides, currents, ice, and snow conditions), is often used when determining what, where, and when a subsistence resource will be harvested.

While some harvest locations may be used infrequently, they can still be important to a subsistence user or a community if they are particularly productive areas or if they have cultural, historical, or familial significance to the user. Prior to the 1950s, when mandatory school attendance and economic factors such as a decline in fur prices compelled families to permanently settle in one of the few centralized communities, the Iñupiat were highly mobile and ranged over large geographic areas for trapping, fishing, gathering, and hunting activities. Contemporary subsistence use areas include many of these traditional use areas. The advent of snowmachines and all-terrain vehicles (ATVs) including four-wheelers has reduced the time required to travel to traditional hunting and harvesting areas, but has also increased the need for cash employment to purchase, maintain, and procure supplies for the new equipment (Ahtuangaruak 1997, Impact Assessment Inc. [IAI] 1990a, b, Stephen R. Braund & Associates [SRB&A] and Institute of Social and Economic Research [ISER] 1993, Worl and Smythe 1986). The nomadic land use patterns once typical of North Slope Iñupiat evolved to the use of base camps consisting of tent platforms, cabins, and/or caches located near productive resource bases. While the use of camps and cabins continues, the community of Nuiqsut has, in more recent years, become a base from which many residents conduct same-day subsistence activities (IAI 1990b, SRB&A 2010a, SRB&A 2018). The following section provides a brief introduction of

Nuiqsut, followed by a description of their subsistence use areas, harvest data, and seasonal round data as available.

CHAPTER 2: NUIQSUT OVERVIEW

Nuiqsut is located on the Colville River, approximately 35 miles upstream from the Beaufort Sea, in an area that provides abundant fishing, hunting, birding, and gathering opportunities. Although the location is less advantageous for marine mammal harvests, residents regularly travel to the ocean to harvest them. The Colville River is the largest river system on the North Slope and supports the largest overwintering areas for whitefish, which local residents harvest in substantial quantities (Craig 1987; Seigle et al. 2016).

The Nuiqsut area was formerly a place where Iñupiat and Athabascan people gathered to trade and fish, maintaining connections between the Nunamiut of the inland areas and the Tagiugmiut of the coast (Brown 1979). After the passage of the Alaska Native Claims Settlement Act (ANCSA), 27 Iñupiat families from Barrow resettled at Nuiqsut to live a more traditional lifestyle and to reconnect with familial ties to the area (IAI 1990a). Easy access to the main channel of the Colville River for fishing and hunting and for ease of movement between upriver hunting sites and downriver whaling and sealing sites was the primary reason for selection of the site (Brown 1979).

Since its resettlement, Nuiqsut has grown to a population of 449 residents living in 138 households (North Slope Borough [NSB] 2015). Primary sources of employment in the community include the village corporation (Kuukpik Corporation), the North Slope Borough (NSB), and the NSB school district (NSB 2017). Nuiqsut is one of 11 Alaska Eskimo bowhead whaling communities. It is the closest community to the major oil producing fields of the North Slope, which has impacted local subsistence activities (Fuller and George 1999, IAI 1990a, Pedersen et al. 2000), jobs, corporate dividends, and local revenue.

2.1 Subsistence Use Areas

Figure F-1 depicts Nuiqsut all resources subsistence use areas for multiple time periods, as documented by Pedersen (1979, 1986), BLM (2004), SRB&A (2010a), and Brown et al. (2016). Pedersen's (1979) lifetime (pre-1979) use areas show Nuiqsut residents utilizing a large area centered on the community to harvest subsistence resources; reported use areas extended offshore approximately 15 miles, as far east as Camden Bay, south along the Itkillik River, and west as far as Teshekpuk Lake. Subsequent use area data shows Nuiqsut residents traveling across a progressively larger area to harvest subsistence resources. SRB&A's (2010a) use areas (1995-2006) document Nuiqsut residents traveling beyond Atqasuk in the west, offshore more than 50 miles northeast of Cross Island, overland to Cape Halkett and Barrow in the north, to Camden Bay in the east, and beyond the Colville River in the south. The majority of Nuiqsut 1995-2006 use areas are concentrated around the Colville River, overland areas to the southwest of the community, offshore areas north of the Colville River delta, and northeast of Cross Island. Pedersen (1986) and SRB&A (2003) use areas for Nuiqsut are all within the extent of Pedersen (1979) and SRB&A (2010a) use areas described above with the exception of extending as far as Kaktovik in the east and along the Anaktuvuk River as far as Anaktuvuk Pass to the south. SRB&A (2010a) notes that wolf and wolverine use areas continued farther south toward Anaktuvuk Pass but were not documented due to the size of the map used during interviews. Use areas documented by ADF&G for the 2014 study year (Brown et al. 2016) show use areas occurring within those documented by SRB&A (2010a) but with overland areas extending farther south to Anaktuvuk Pass. Nuiqsut all resources use areas from all available studies (Pedersen 1979, Pedersen 1986, SRB&A 2003, SRB&A 2010a, and Brown et al. 2016) overlap with large portions of the project study area.

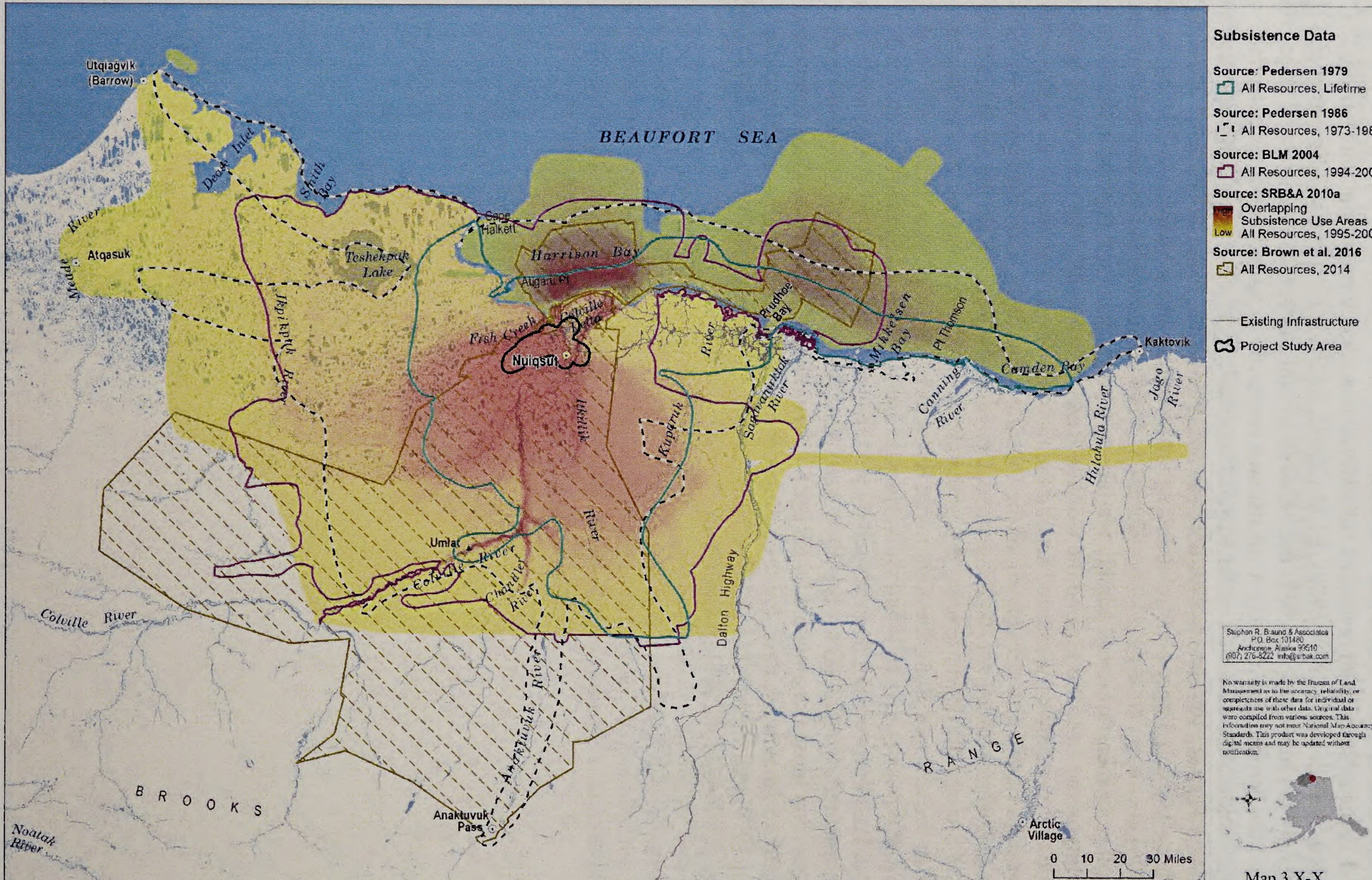

Figure F-1: Nuiqsut Subsistence Use Areas, All Resources

Nuiqsut subsistence use area maps organized by resource are shown on Figure F-2 through Figure F-9 for the lifetime (pre-1979), 1973-1986, 1994-2003, 1995-2006, 2008-2016, and 2014 time periods. Nuiqsut subsistence use areas for large land mammals are shown on Figure F-2 through Figure F-4. Nuiqsut caribou use areas are shown on Figure F-2 and include use areas documented by Pedersen (1979), Pedersen (1986), BLM (2004), SRB&A (2010a), Brown et al. (2016), and nine years of caribou monitoring studies summarized most recently in SRB&A 2018. As indicated on the map, areas consistently used by Nuiqsut residents for caribou hunting occur in an overland area between the Ikpikpuk and Kuparuk Rivers, north to the coast, and south along the Colville River. The maximum extent of their use areas documented between all the studies extends from Atqasuk in the west towards Point Thomson in the east and south along the Colville and Anaktuvuk Rivers to Anaktuvuk Pass. SRB&A's (2010a) overlapping use areas show the greatest number of caribou use areas are concentrated along the Colville River and delta, along the Itkillik River, and overland to the west and south of the community; these areas correspond to the caribou hunting areas reported during the 2008 through 2016 study years (SRB&A 2018).

Nuiqsut moose use areas (Figure F-3) as documented by Pedersen (1979, 1986), BLM (2004) SRB&A (2010a), and Brown et al. (2016) show residents' consistent use of areas adjacent to the Colville River for moose harvests. While lifetime (pre-1979) use areas were completely confined to the Colville River, more recent moose use areas for the 1973-1986, 1994-2003, and 1995-2006 time periods have expanded to include other tributaries including the Chandler and Anaktuvuk Rivers and Fish Creek. The most recent 2014 moose use areas were confined to the Colville and Itkillik Rivers in that particular study year. The 1995-2006 moose use areas show the highest amount of overlap along the Colville River south of Nuiqsut as far as Umiat.

Figure F-4 depicts Nuiqsut use areas for grizzly bear as documented by Pedersen (1979, 1986). Use areas for grizzly bear for the lifetime and 1973-1986 time periods include areas along the Colville River watershed from Fish Creek to Umiat.

Nuiqsut small land mammal use areas are shown on Figure F-5 for the lifetime, 1973-1986, 1994-2003, 1995-2006, and 2014 time periods. Lifetime (pre-1979) use areas documented by Pedersen (1979) showed residents using overland areas near the community, as well as the more southern Colville, Chandler, Anaktuvuk, Itkillik, and Kuparuk Rivers to harvest small land mammals. Pedersen's (1986) furbearer and small land mammal use areas for the 1973-1986 time period expanded from previously recorded use areas to the west beyond the Ikpikpuk River and south to Anaktuvuk Pass. SRB&A's (2010a) wolf and wolverine use areas for the 1995-2006 time period indicate a farther expansion of use areas to the Meade River in the west and beyond the Dalton Highway in the east, including an eastward area reaching to just south of Kaktovik. Small land mammal use areas for 2014 from the most recent Brown et al. (2016) study indicated fewer use areas extending as far east and west of the community and an expansion of use areas into the Brooks Range.

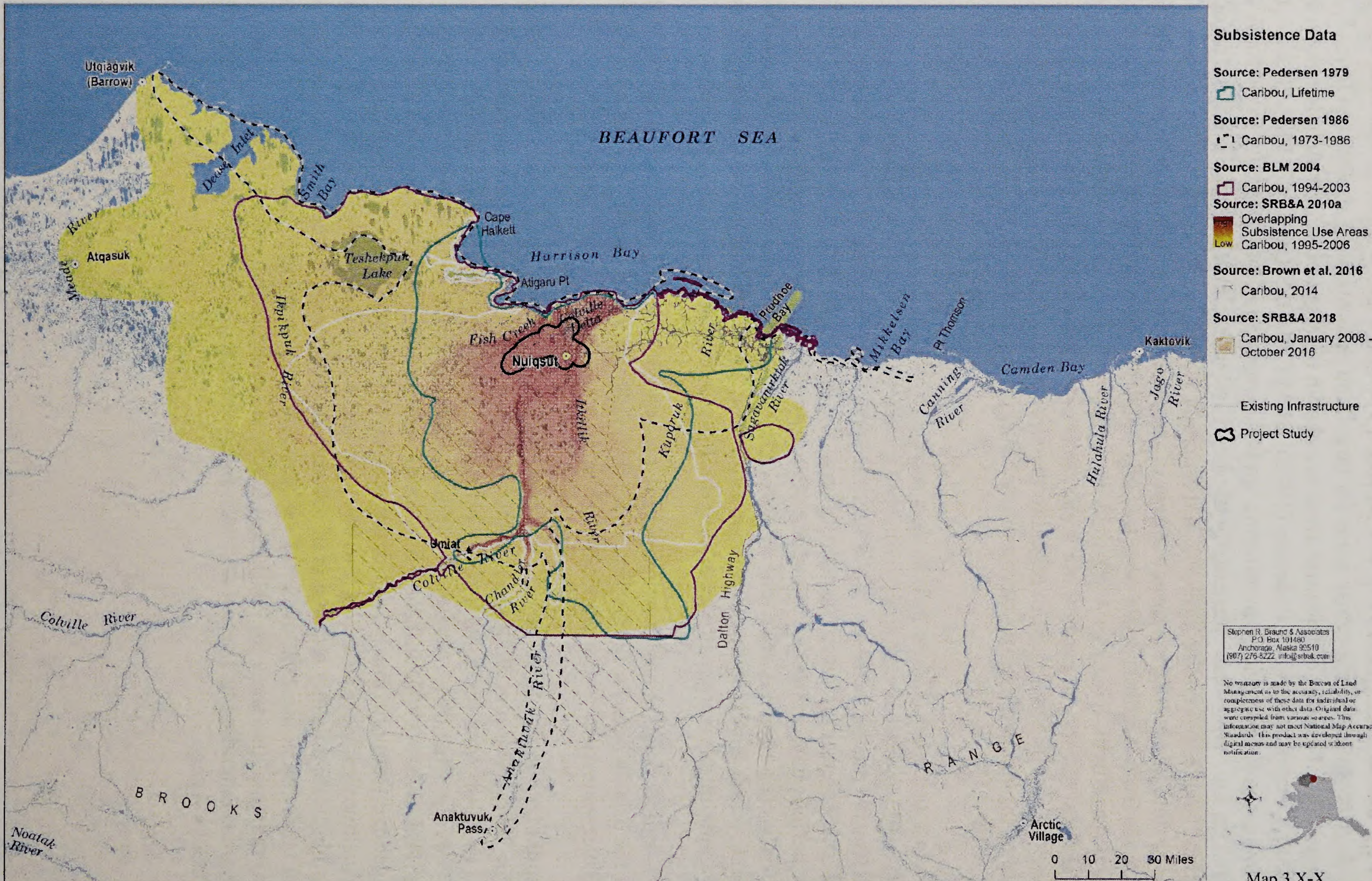

Figure F-2: Nuiqsut Subsistence Use Areas, Caribou

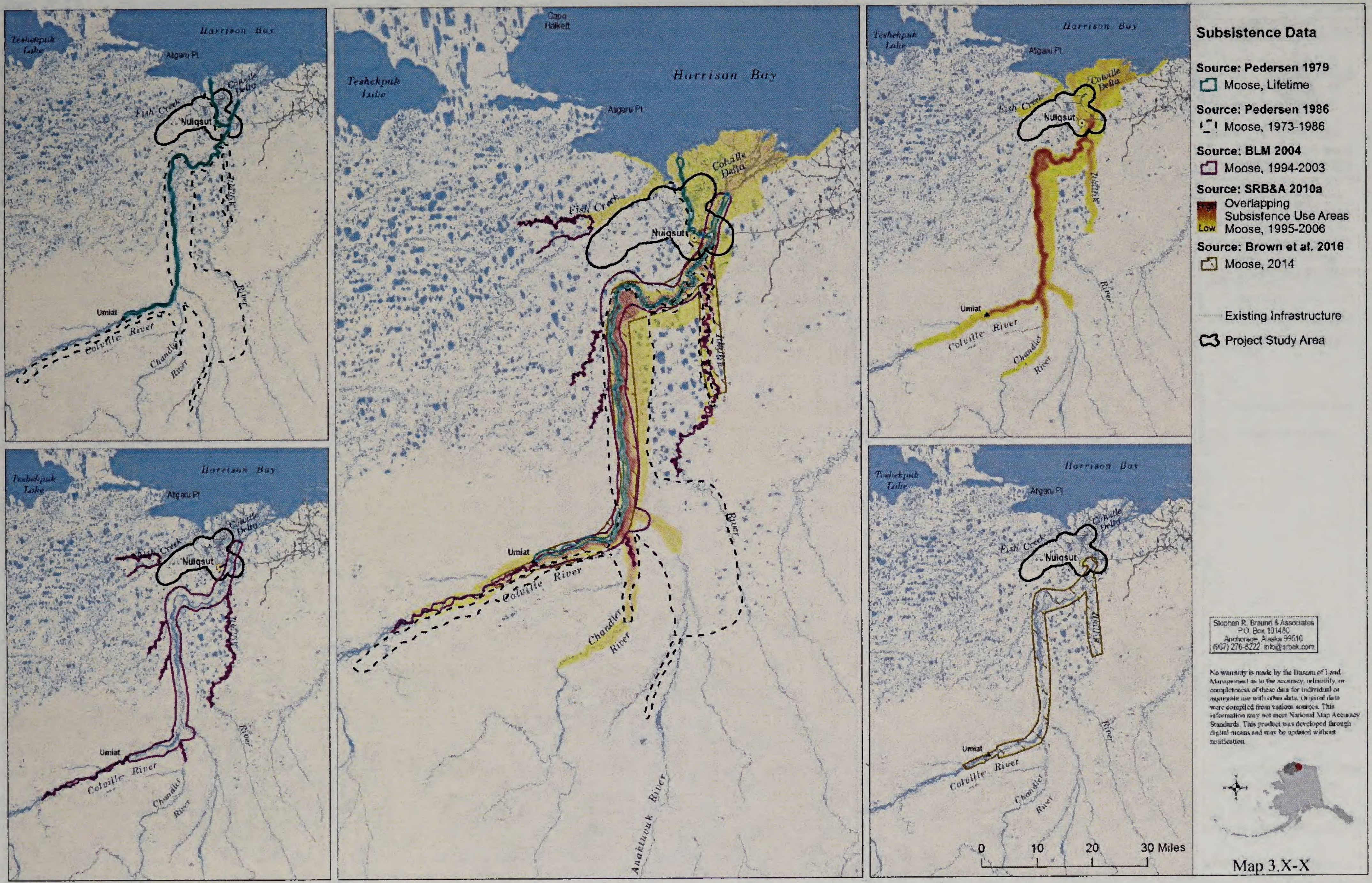

Figure F-3: Nuiqsut Subsistence Use Areas, Moose

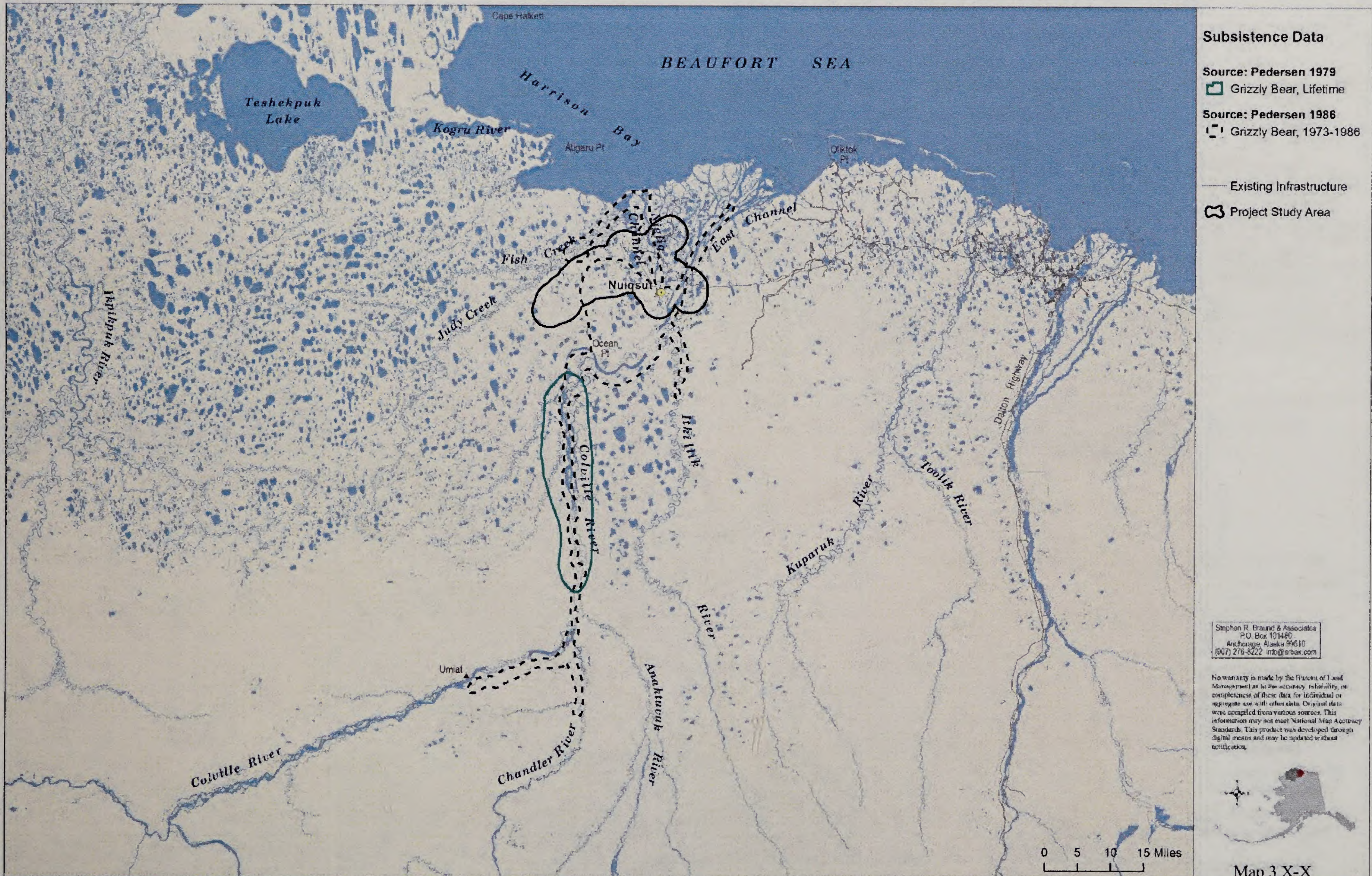

Figure F-4: Nuiqsut Subsistence Use Areas, Other Large Land Mammals

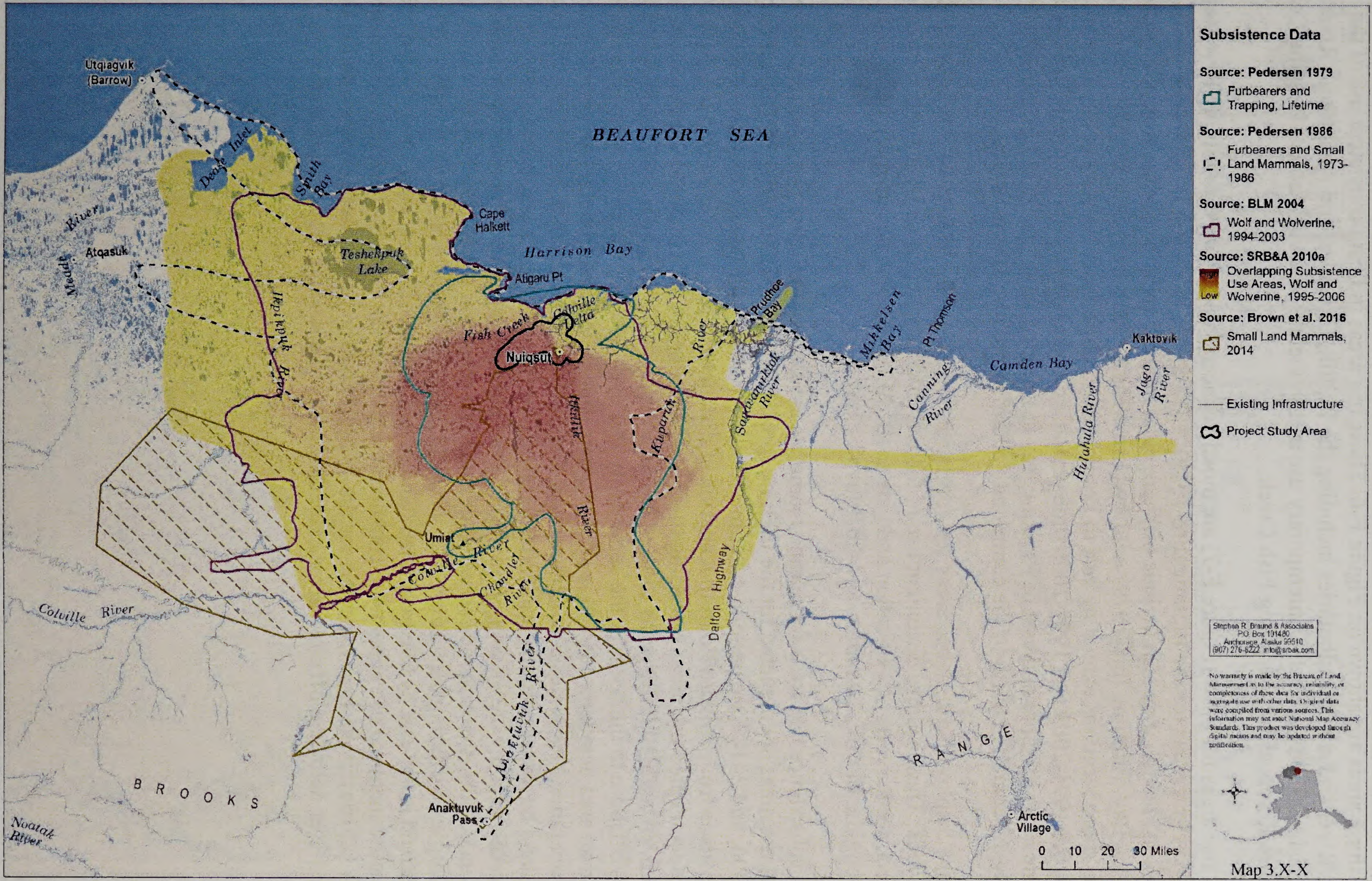

Figure F-5: Nuiqsut Subsistence Use Areas, Furbearers and Small Land Mammals

Nuiqsut lifetime (1973-1986 and pre-1979) and more contemporary (1994-2003, 1995-2006, 2014) fishing areas are shown on Figure F-6. These use areas indicate consistent use of the Colville River and smaller tributaries including the Itkillik, Chandler, and Anaktuvuk Rivers as well as Fish and Judy creeks. Contemporary use areas extend somewhat father along the Colville and Itkillik Rivers as well as along Fish Creek.

Nuiqsut use areas for birds (Figure F-7) are mostly concentrated along the Colville River and nearby overland areas for the lifetime (pre-1979), 1973-1986, 1994-2003, 1995-2006, and 2014 time periods, though they also include offshore eider hunting areas extending from Cape Halkett to Camden Bay. Lifetime (pre-1979) wildfowl use areas include areas near the Colville River and near-shore locations extending east to Prudhoe Bay. More recent use areas for geese and eider for the 1994-2003 and 1995-2006 time period expanded previously recorded bird use areas to include areas offshore and east of Prudhoe Bay to Camden Bay. The 2014 bird use areas were primarily concentrated north of the community and offshore into Harrison Bay.

Figure F-8 displays Nuiqsut use areas for vegetation for the 1973-1986, 1994-2003, and 2014 time periods. These studies document use of the Colville River as far as Umiat and areas near Fish Creek for harvests of vegetation and berries. BLM (2004) also documented berry gathering areas along the Itkillik, Chandler, and Anaktuvuk Rivers.

Nuiqsut subsistence use areas for marine mammals are shown on Figure F-9. Nuiqsut marine mammal use areas are depicted for the lifetime (pre-1979), 1973-1986, 1994-2003 (seal only), 1995-2006, and 2014 time periods. Lifetime Nuiqsut use areas for marine mammals included offshore areas from Atigaru Point to Kaktovik at distances of less than 20 miles; subsequent studies documented use areas extending to Cape Halkett in the west and varying distances to the east. SRB&A's (2010a) use areas showed Nuiqsut residents harvesting marine mammals up to 40 miles offshore to the north of the community and even farther offshore (approximately 60 miles) in an area near Cross Island, a sandy barrier island used traditionally and currently as a base of operations for Nuiqsut whaling crews. Galginaitis (2009a, 2009b, and 2010) documented Cross Island bowhead whaling tracks from 2001-2009. These tracks were recorded by participating whaling crews using Geographic Positioning System (GPS) units for an ongoing MMS funded subsistence bowhead whaling study and represent actual boat hunting routes taken by whaling crews during each study year. Nuiqsut 2001-2009 bowhead whale hunting GPS tracks extend as far east as Flaxman Island and over 30 miles offshore from Cross Island. The 2014 marine mammal use areas were concentrated in the areas of highest overlap documented by SRB&A (2010a). Polar bear use areas for the 1973-1986 time period were documented in the Colville River delta and offshore areas extending east to Cross and Tigvariak islands.

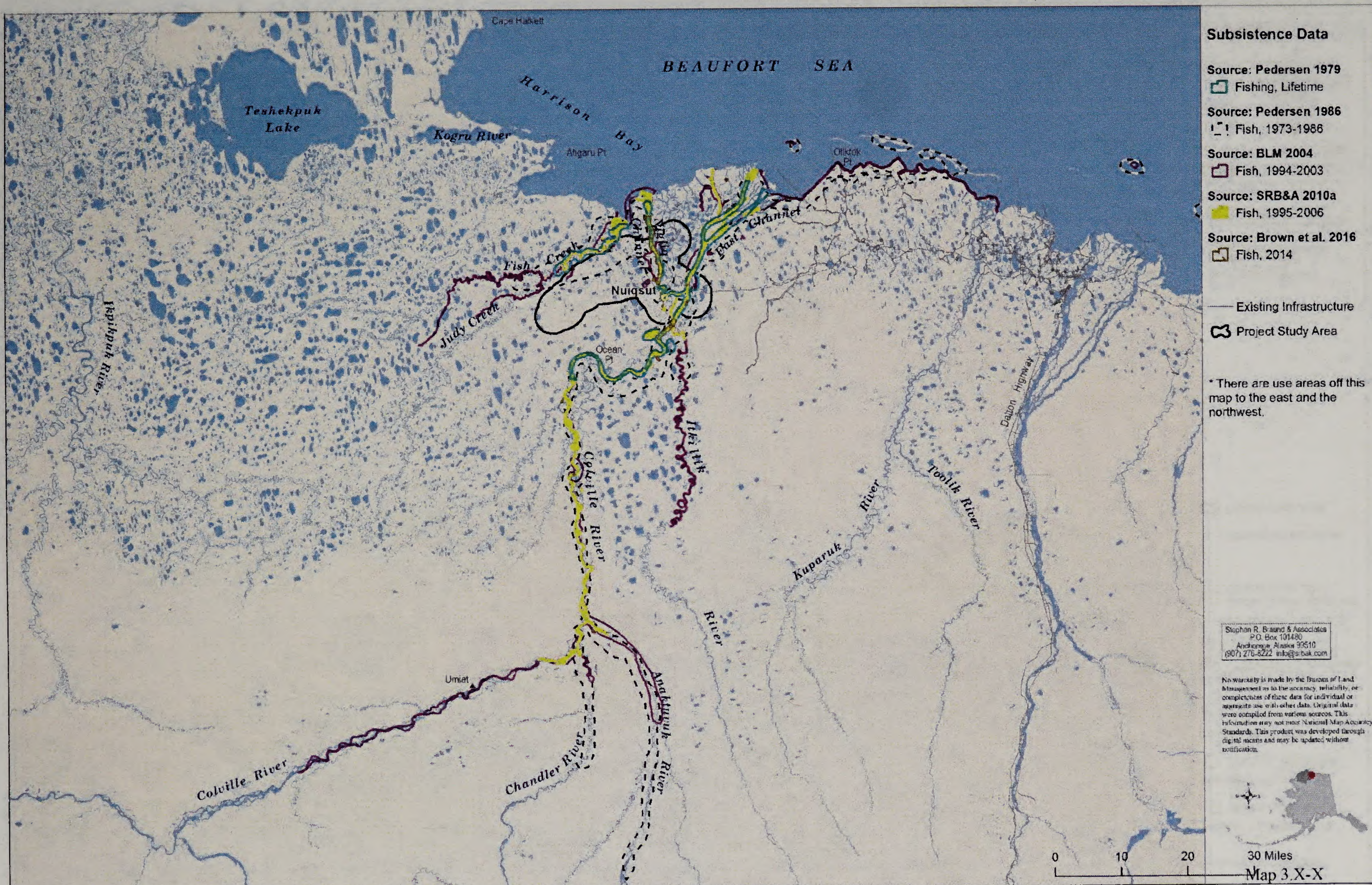

Figure F-6: Nuiqsut Subsistence Use Areas, Fish

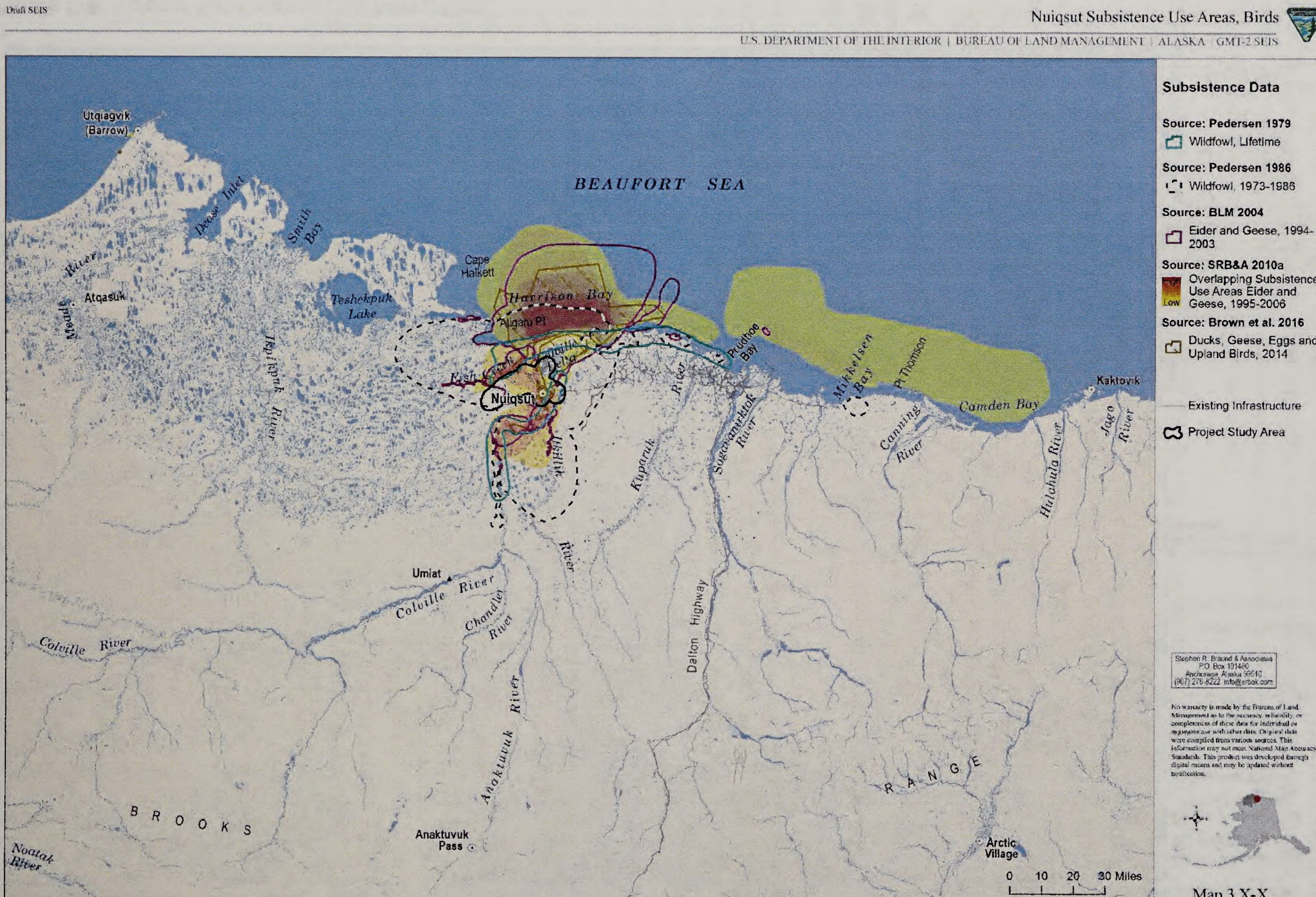

Figure F-7: Nuiqsut Subsistence Use Areas, Birds

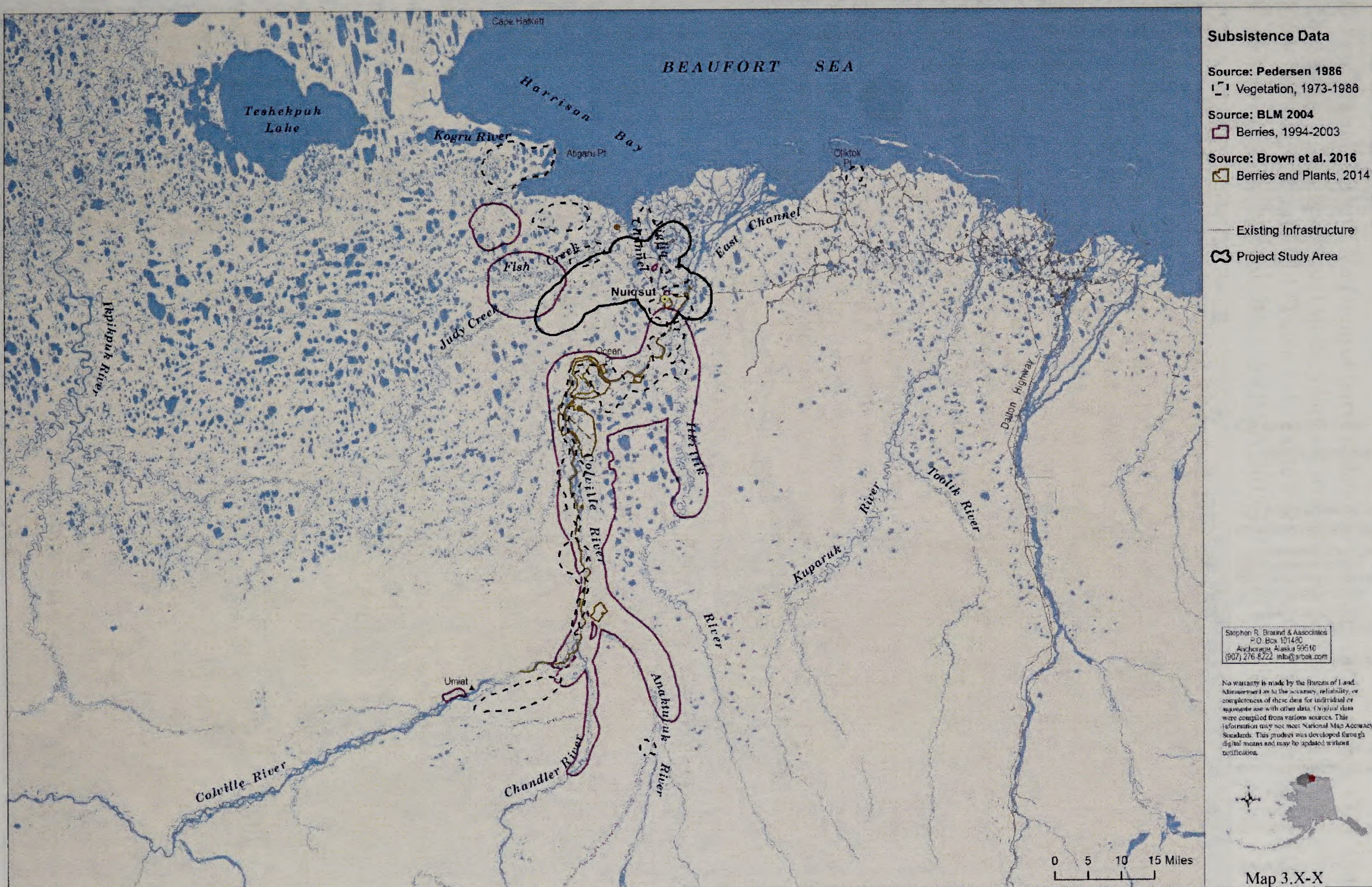

Figure F-8: Nuiqsut Subsistence Use Areas, Vegetation

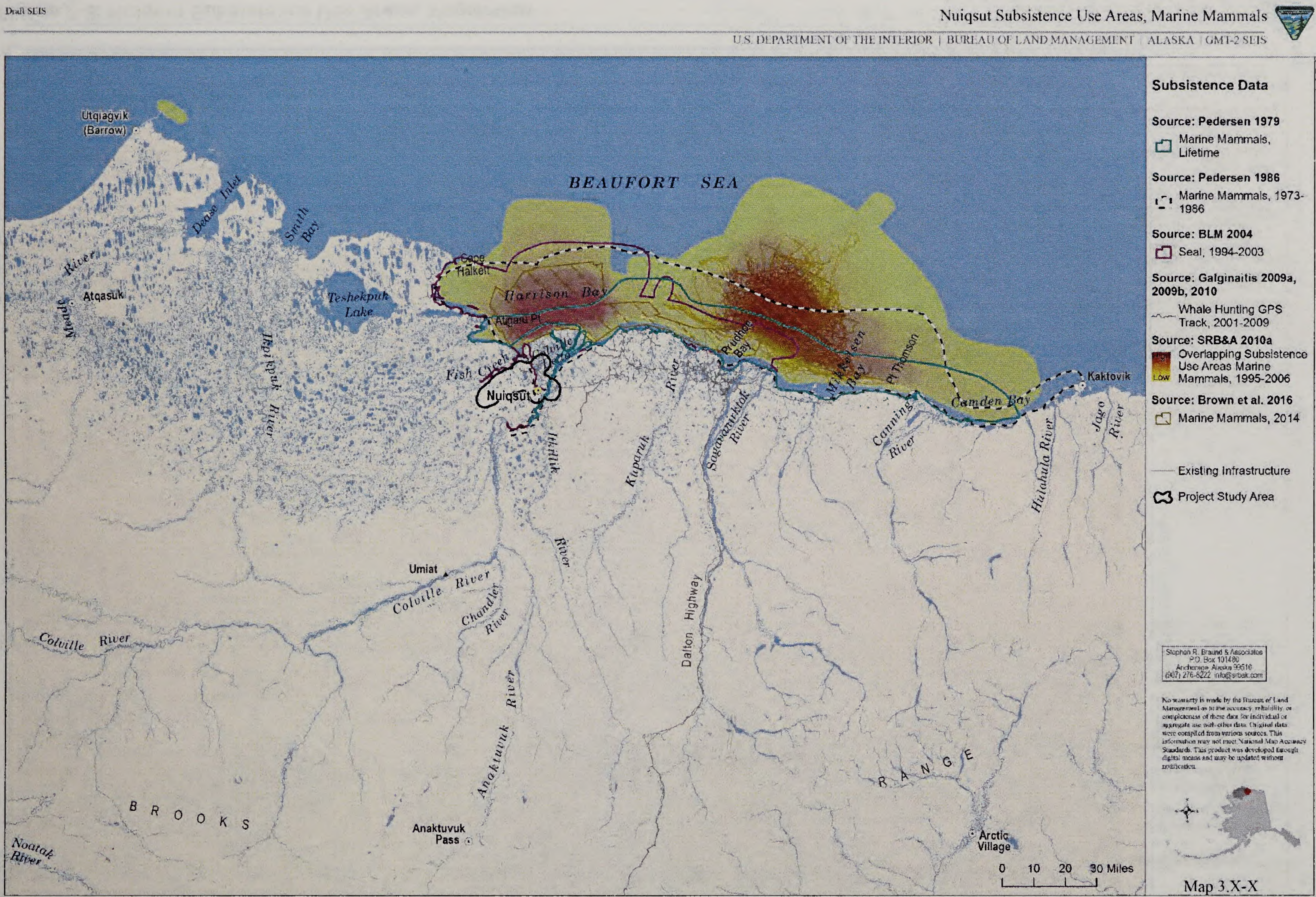

Figure F-9: Nuiqsut Subsistence Use Areas, Marine Mammals

2.2 Harvest Data

Table F-1 and Table F-2 provide Nuiqsut harvest data for various years between 1985 and 2016. Comprehensive (i.e., all resources) study years are available for 1985, 1992, 1993, 1994-1995, 1995-1996, 2000-2001, and 2014 (Table F-1, Table F-2). Twelve study years include data solely for caribou harvests (Braem et al. 2011, SRB&A 2012-2018) (Table F-2).

During years with per capita harvest data, Nuiqsut households harvested between 399 in 1985 (a year when the community did not successfully harvest a bowhead whale) and 896 in 2014 pounds of subsistence resources per capita (Table F-1). Land mammals, marine mammals, and fish are all major subsistence resources in Nuiqsut. Table F-1 shows that marine mammals contributed more total edible pounds during four comprehensive study years (1992, 1995-1996, 2000-2001, and 2014) than any other resource. Non-salmon fish were the top harvested resource during the remaining three study years (1985, 1993, and 1994-1995) and accounted for between 173 (in 1985) and 248 (in 1993) pounds per capita during years with per capita harvest data. Large land mammals were generally the second or third most harvested resource during all study years and provided between 169 (in 1985) and 261 (in 2014) pounds per capita. In smaller quantities, Nuiqsut residents harvest migratory birds (between 10 and 17 pounds per capita); upland game birds (between <1 and 3 pounds per capita); salmon (between 3 and 9 pounds per capita); and bird eggs and vegetation (no more than one pound per capita). Small land mammals are also harvested, but because they are harvested primarily for their fur, they contribute little in the way of edible pounds.

Specifically, bowhead whales, whitefish (Arctic cisco, or *qaaktaq*, and broad whitefish), and caribou are the primary subsistence species harvested in Nuiqsut. Bowhead whale harvests accounted for between 28.7 percent and 60.3 percent of the total harvest during all study years (except for 1985 and 1994-1995, when Nuiqsut did not successfully harvest a whale). Arctic cisco harvests have accounted for between 1.9 and 14.9 percent of the total harvest, broad whitefish have accounted for between 5.3 and 45 percent of the total harvest, and caribou have accounted for between 21.7 and 37.5 percent of the total harvest. Other subsistence species with substantial contributions to Nuiqsut subsistence harvests include moose, seals, geese, Arctic grayling, least cisco, and burbot.

Household participation data (in terms of percentage of households harvesting) are available for four comprehensive study years (1985, 1992, 1993, 2014) and 10 caribou only study years (2002-03, 2003-04, 2004-05, 2005-06, 2006-07, 2010-2013, 2015, and 2016). Nuiqsut relies heavily on subsistence resources. As shown in Table F-1, 100 percent of households reported using subsistence resources in 1985, 1993, and 2014, and over 90 percent of households participated in subsistence activities (i.e., attempted to harvest). During all available study years, participation in subsistence activities was highest for non-salmon fish, large land mammals, and migratory birds. Specifically, in 2014, over half of Nuiqsut households participated in harvests of caribou, broad whitefish, white-fronted geese, cloudberries, and Arctic cisco. In 2016, 76 percent of households participated in caribou hunting activities. Sharing of subsistence resources is also high; 100 percent of households received resources in 1985, 98 percent in 1993, and 97 percent in 2014. Sharing of subsistence foods is particularly common with marine mammals (between 95 and 100 percent of households receiving); large land mammals (between 70 and 92 percent); and non-salmon fish (between 71 and 90 percent).

Table F-1: Nuiqsut Subsistence Harvest Estimates by Resource Category, All Resources Study Years

Study Year	Resource	Percentage of Households					Estimated Harvest				% of Total Harvest
		Use	Try to Harvest	Harvest	Give	Receive	Number*	Total Pounds**	Average HH Pounds	Per Capita Pounds	
1985	All Resources	100	98	98	95	100	-	160,035	2,106	399	100.0%
	Salmon	60	43	40	23	23	441	1,366	18	3	0.9%
	Non-Salmon Fish	100	93	93	83	75	67,712	69,243	911	173	43.3%
	Large Land Mammals	98	90	90	80	70	536	67,621	890	169	42.3%
	Small Land Mammals	65	63	58	23	13	688	245	3	1	0.2%
	Marine Mammals	100	48	23	30	100	59	13,355	176	33	8.3%
	Migratory Birds	90	90	85	60	55	1,733	6,626	87	17	4.1%
	Upland Game Birds	88	88	88	58	13	1,957	1,370	18	3	0.9%
	Bird Eggs	25	25	23	8	10	262	40	1	<1	<0.1%
	Vegetation	38	50	18	10	20	-	169	2	<1	0.1%
1992***	All Resources	-	-	-	-	-	-	150,195	-	-	100.0%
	Salmon	-	-	-	-	-	6	65	-	-	0.0%
	Non-Salmon Fish	-	74	-	-	-	36,701	51,890	-	-	34.5%
	Large Land Mammals	-	-	-	-	-	299	41,386	-	-	27.6%
	Small Land Mammals	-	-	-	-	-	46	1	-	-	0.0%
	Marine Mammals	-	-	-	-	-	49	52,865	-	-	35.2%
	Migratory Birds	-	-	-	-	-	1,105	3,655	-	-	2.4%
	Upland Game Birds	-	-	-	-	-	378	265	-	-	0.2%
	Eggs	-	-	-	-	-	25	4	-	-	<0.1%
	Vegetation	-	32	-	-	-	-	66	-	-	<0.1%

Study Year	Resource	Percentage of Households					Estimated Harvest				% of Total Harvest
		Use	Try to Harvest	Harvest	Give	Receive	Number*	Total Pounds**	Average HH Pounds	Per Capita Pounds	
1993	All Resources	100	94	90	92	98	-	267,818	2,943	742	100.0%
	Salmon	71	45	36	39	47	272	1,009	11	3	0.4%
	Non-Salmon Fish	97	79	79	87	90	71,626	89,481	983	248	33.4%
	Large Land Mammals	98	76	74	82	92	691	87,306	959	242	32.6%
	Small Land Mammals	53	45	42	27	18	599	84	1	<1	<0.1%
	Marine Mammals	97	58	37	79	97	113	85,216	936	236	31.8%
	Migratory Birds	87	74	73	63	65	2,238	3,540	39	10	1.3%
	Upland Game Birds	60	45	45	42	26	973	681	7	2	0.3%
	Eggs	40	21	19	15	23	346	104	1	<1	<0.1%
	Vegetation	79	71	71	27	40	-	396	4	1	0.1%
1994-95****	All Resources	-	-	-	-	-	-	83,228	-	-	100.0%
	Salmon	-	-	-	-	-	10	31	-	-	<0.1%
	Non-Salmon Fish	-	-	-	-	-	15,190	46,569	-	-	56.0%
	Large Land Mammals	-	-	-	-	-	263	32,686	-	-	39.3%
	Small Land Mammals	-	-	-	-	-	42	0	-	-	0.0%
	Marine Mammals	-	-	-	-	-	25	1,504	-	-	1.8%
	Migratory Birds	-	-	-	-	-	569	2,289	-	-	2.8%
	Upland Game Birds	-	-	-	-	-	58	58	-	-	0.1%
	Vegetation	-	-	-	-	-	14	91	-	-	0.1%

Study Year	Resource	Percentage of Households					Estimated Harvest				% of Total Harvest
		Use	Try to Harvest	Harvest	Give	Receive	Number*	Total Pounds**	Average HH Pounds	Per Capita Pounds	
1995-96	All Resources	-	-	-	-	-	-	183,576	-	-	100.0%
	Salmon	-	-	-	-	-	42	131	-	-	0.1%
	Non-Salmon Fish	-	-	-	-	-	10,612	16,822	-	-	9.2%
	Large Land Mammals	-	-	-	-	-	364	43,554	-	-	23.7%
	Small Land Mammals	-	-	-	-	-	27	0	-	-	0.0%
	Marine Mammals	-	-	-	-	-	178	120,811	-	-	65.8%
	Migratory Birds	-	-	-	-	-	683	2,166	-	-	1.2%
	Upland Birds	-	-	-	-	-	19	13	-	-	<0.1%
	Vegetation	-	-	-	-	-	12	78	-	-	<0.1%
2000-01	All Resources	-	-	-	-	-	-	183,246	-	-	100.0%
	Salmon	-	-	-	-	-	10	75	-	-	<0.1%
	Non-Salmon Fish	-	-	-	-	-	26,545	27,933	-	-	15.2%
	Large Land Mammals	-	-	-	-	-	504	62,171	-	-	33.9%
	Small Land Mammals	-	-	-	-	-	108	2	-	-	<0.1%
	Marine Mammals	-	-	-	-	-	31	87,929	-	-	48.0%
	Migratory Birds	-	-	-	-	-	1,192	5,108	-	-	2.8%
	Upland Birds	-	-	-	-	-	23	16	-	-	<0.1%
	Vegetation	-	-	-	-	-	2	13	-	-	<0.1%

Study Year	Resource	Percentage of Households					Estimated Harvest				% of Total Harvest
		Use	Try to Harvest	Harvest	Give	Receive	Number*	Total Pounds**	Average HH Pounds	Per Capita Pounds	
2014	All Resources	100	95	90	91	97	-	371,992	3,444	896	100.0%
	Salmon	64	41	40	31	35	-	3,889	36	9	1.0%
	Non-Salmon Fish	93	78	71	72	71	-	85,106	788	205	22.9%
	Large Land Mammals	91	66	64	67	72	-	108,359	1,003	261	29.1%
	Small Land Mammals	17	16	10	2	7	-	0	0	0	0.0%
	Marine Mammals	95	55	40	71	95	-	169,367	1,568	408	45.5%
	Migratory Birds	79	71	66	52	38	-	4,742	44	11	1.3%
	Upland Birds	16	12	12	9	5	-	78	1	<1	0.0%
	Vegetation	67	55	53	21	38	-	414	4	1	0.1%

Notes: *Estimated numbers represent individuals in all cases except vegetation, where they represent gallons.
**Estimated pounds include only edible pounds and therefore do not include estimates for resources that are not typically eaten by community residents (e.g., furbearers).
***The estimated pounds of moose harvested in 1992 is likely too high (Fuller and George 1999).
****The 1994-95 study year underrepresents the harvest of Arctic cisco and humpback whitefish (Brower and Hepa 1998); Nuiqsut did not successfully harvest a bowhead whale in 1994-95.

The estimated harvest numbers for the 1994-95, 1995-96 and 2000-01 data were derived by summing individual species in each resource category. Also for those study years, total pounds were derived from conversion rates found at ADF&G (2017) and total (usable) pounds for bowhead whales were calculated based on the method presented in SRB&A and ISER (1993). These estimates do not account for whale girth and should be considered approximate; more exact methods for estimating total whale weights are available in George et al. (n.d.).

Sources: ADF&G, 2017 (1985); Bacon et al., 2009 (1995-96, 2000-01); Brower and Hepa, 1998 (1994-95); Brown et al., 2016 (2014); Fuller and George, 1999 (1992); and Pedersen, 1995 (1993).

Table F-2: Nuiqsut Subsistence Harvest Estimates by Selected Species, All Study Years

Study Year	Resource*	Percentage of Households					Estimated Harvest				% of Total Harvest
		Use	Try to Harvest	Harvest	Give	Receive	Number**	Total Pounds***	Average HH Pounds	Per Capita Pounds	
1985	Caribou	98	90	90	80	60	513	60,021	790	150	37.5%
	Cisco	98	75	73	65	60	46,478	29,354	386	73	18.3%
	Broad Whitefish	95	80	78	70	40	7,900	26,861	353	67	16.8%
	Bowhead Whale	100	23	5	8	100	0	7,458	98	19	4.7%
	Moose	40	40	18	20	25	13	6,650	88	17	4.2%
	White-fronted Geese	90	90	85	55	48	1,340	6,028	79	15	3.8%
	Arctic Grayling	78	65	63	48	35	4,055	3,650	48	9	2.3%
	Humpback Whitefish	48	45	38	33	13	4,345	3,476	46	9	2.2%
	Arctic Char	75	63	60	33	35	1,060	2,969	39	7	1.9%
	Burbot	75	60	60	43	33	669	2,675	35	7	1.7%
	Bearded Seal	48	25	15	15	35	15	2,675	35	7	1.7%
	Ringed Seal	53	25	18	23	40	40	1,676	22	4	1.0%
1992	Bowhead Whale	-	-	-	-	-	2	48,715	-	-	32.4%
	Caribou	-	81	-	-	-	278	32,551	-	-	21.7%
	Arctic Cisco	-	-	-	-	-	22,391	22,391	-	-	14.9%
	Broad Whitefish	-	-	-	-	-	6,248	15,621	-	-	10.4%
	Moose****	-	-	-	-	-	18	8,835	-	-	5.9%
	Humpback Whitefish	-	-	-	-	-	1,802	4,504	-	-	3.0%
	Arctic Char	-	-	-	-	-	1,544	4,324	-	-	2.9%
	Bearded Seal	-	-	-	-	-	16	2,760	-	-	1.8%
	Arctic Grayling	-	-	-	-	-	3,114	2,491	-	-	1.7%
	Canada Geese	-	-	-	-	-	319	1,437	-	-	1.0%

Study Year	Resource*	Percentage of Households					Estimated Harvest				% of Total Harvest
		Use	Try to Harvest	Harvest	Give	Receive	Number**	Total Pounds***	Average HH Pounds	Per Capita Pounds	
1993	Caribou	98	74	74	79	79	672	82,169	903	228	30.7%
	Bowhead Whale	97	37	5	76	97	3	76,906	845	213	28.7%
	Broad Whitefish	90	66	66	65	66	12,193	41,455	456	115	15.5%
	Arctic Cisco	89	69	68	81	60	45,237	31,666	348	88	11.8%
	Ringed Seal	65	42	31	40	55	98	7,277	80	20	2.7%
	Burbot	79	63	57	53	55	1,416	5,949	65	16	2.2%
	Moose	69	47	10	29	63	9	4,403	48	12	1.6%
	Arctic Grayling	79	69	65	44	27	4,515	4,063	45	11	1.5%
	Least Cisco	63	52	47	36	27	6,553	3,277	36	9	1.2%
1994-95*****	Broad Whitefish	-	-	-	-	-	3,237	37,417	-	-	45.0%
	Caribou	-	-	-	-	-	258	30,186	-	-	36.3%
	Arctic Cisco	-	-	-	-	-	9,842	6,889	-	-	8.3%
	Moose	-	-	-	-	-	5	2,500	-	-	3.0%
	Geese Unidentified	-	-	-	-	-	474	2,133	-	-	2.6%
	Ringed Seal	-	-	-	-	-	24	1,008	-	-	1.2%
1995-96	Bowhead Whale	-	-	-	-	-	4	110,715	-	-	60.3%
	Caribou	-	-	-	-	-	362	42,354	-	-	23.1%
	Broad Whitefish	-	-	-	-	-	2,863	9,735	-	-	5.3%
	Ringed Seal	-	-	-	-	-	155	6,527	-	-	3.6%
	Arctic Cisco	-	-	-	-	-	5,030	3,521	-	-	1.9%
	Bearded Seal	-	-	-	-	-	17	2,974	-	-	1.6%
	Least Cisco	-	-	-	-	-	1,804	1,804	-	-	1.0%
1999-00	Caribou	-	-	-	-	-	413	-	-	112	-

Study Year	Resource*	Percentage of Households					Estimated Harvest				% of Total Harvest
		Use	Try to Harvest	Harvest	Give	Receive	Number**	Total Pounds***	Average HH Pounds	Per Capita Pounds	
2000-01	Bowhead Whale	-	-	-	-	-	4	86,220	-	-	47.1%
	Caribou	-	-	-	-	-	496	57,985	-	-	31.6%
	Arctic Cisco	-	-	-	-	-	18,222	12,755	-	-	7.0%
	Broad Whitefish	-	-	-	-	-	2,968	10,092	-	-	5.5%
	White-fronted Geese	-	-	-	-	-	787	3,543	-	-	1.9%
	Moose	-	-	-	-	-	6	3,000	-	-	1.6%
2002-03	Caribou	95	47	45	49	80	397	-	-	118	-
2003-04	Caribou	97	74	70	81	81	564	-	-	157	-
2004-05	Caribou	99	62	61	81	96	546	-	-	147	-
2005-06	Caribou	100	60	59	97	96	363	-	-	102	-
2006-07	Caribou	97	77	74	66	69	475	-	-	143	-
2010	Caribou	94	86	76	-	-	562	65,754	707	-	-
2011	Caribou	92	70	56	49	58	437	51,129	544	134	-
2012	Caribou	99	68	62	65	79	501	58,617	598	147	-
2013	Caribou	95	79	63	62	75	586	68,534	692	166	-
2014	Bowhead	93	29	21	57	91	5	148,087	1,371	357	39.8%
	Caribou	90	66	64	67	59	774	105,193	974	253	28.3%
	Broad Whitefish	72	60	59	52	40	11,439	36,605	339	88	9.8%
	Arctic Cisco	83	52	48	59	53	46,277	32,394	300	78	8.7%
	Bearded Seal	67	38	22	40	62	13,846	13,846	128	33	3.7%
	Least Cisco	33	28	28	19	7	13,332	9,333	86	22	2.5%
	Ringed Seal	52	40	35	38	33	108	6,156	57	15	1.7%
2015	Caribou	96	84	78	74	72	628	73,527	728	180	-
2016	Caribou	96	76	67	79	81	481	56,277	592	132	-

Notes: *This table shows individual species unless they are not available for a given study year.
**Estimated numbers represent individuals in all cases except vegetation, where they represent gallons.
***Estimated pounds include only edible pounds and therefore do not include estimates for resources that are not typically eaten by community residents (e.g., furbearers).
****The estimated pounds of moose harvested in 1992 is likely too high (Fuller and George, 1999).
*****The 1994-95 study year underrepresents the harvest of Arctic cisco and humpback whitefish (Brower and Hepa 1998); Nuiqsut did not successfully harvest a bowhead whale in 1994-95.

For All Resources study years (1985, 1992, 1993, 1994-95, 1995-96, 2000-01), species are listed in descending order by percent of total harvest and are limited to species accounting for at least 1.0 percent of the total harvest; for single-resource study years, species are listed in descending order by total estimated pounds (or total number harvested, in the case of salmon study years) and limited to the five top species. Years lacking "% of total harvest" data were not comprehensive (i.e., all resources) study years.

The estimated harvest numbers for the 1992, 1994-95, 1995-96 and 2000-01 data were derived by summing individual species in each resource category. Also for those study years, total pounds were derived from conversion rates found at ADF&G (2017) and total (usable) pounds for bowhead whales were calculated based on the method presented in SRB&A and ISER (1993). These estimates do not account for whale girth and should be considered approximate; more exact methods for estimating total whale weights are available in George et al. (n.d.). For the 2002-2003, 2003-2004, 2004-2005, 2005-2006, 2006-2007, 2010, and 2011 study years, total pounds were derived from conversion rates from Braem et al. (2011).

Sources: ADF&G, 2017 (1985); Bacon et al., 2009 (1995-96, 2000-01); Braem et al., 2011 (1999-00; 2002-2007); Brower and Hepa, 1998 (1994-95); Brown et al., 2016 (2014); Fuller and George, 1999 (1992), Pedersen, 1995 (1993); and SRB&A, 2012, 2013, 2014, 2015, 2016, 2017, 2018 (2010-2013, 2015-2016).

2.3 Seasonal Round

Table F-3 provides seasonal round data based on reports from the 1970s through the 2010s. The spring month of April marks a transition from the late winter/early spring harvesting of furbearers, seals (through the ice), and upland game birds (ptarmigan) to the spring waterfowl hunting season which peaks in May and June. Some residents also harvest geese eggs after the birds begin nesting in June. Beginning as early as May (depending on the timing of breakup), residents travel by boat along the local river system and into the Beaufort Sea to harvest various resources including caribou, waterfowl, seals, and fish.

Caribou harvests occur throughout the year, but with the most intensity during the summer months of July and August. During this time, residents also set nets for broad whitefish in local river systems or harvest fish such as Arctic grayling and Dolly Varden with rod and reel, often while hunting caribou along the Colville River. In addition to traveling along the Colville River during the summer for fishing and caribou hunting, residents continue to travel to the ocean to hunt for ringed seals, bearded seals, and king and common eiders throughout the summer months (SRB&A 2010a). Berry and plant gathering also occur during the summer, primarily in July and August.

As summer turns to fall (August/September), some residents shift their focus to moose hunting upriver, which often takes place alongside caribou hunting. Summer rod and reel harvests of non-salmon fish, particularly Arctic grayling, continue into the fall as well. Bowhead whaling occurs in September when whaling crews are stationed at Cross Island, with preparations for the whaling season beginning in August. Nuiqsut hunters harvest few polar bears, but if they are harvested it is often during or after the fall whaling season. The fall months of October and November are spent fishing and harvesting caribou close to the community, often by four-wheeler or snowmachine. The Arctic cisco fishery may begin as early as September but is most productive between October and mid-November when the fish are running upriver and residents harvest them in the Colville Delta with gillnets. Other fish, including humpback whitefish, broad whitefish, and least cisco are caught incidentally during this time.

During the winter and early spring months (primarily December through April), furbearer hunters pursue wolves and wolverines, target caribou and ptarmigan as needed and available, and fish for burbot through the ice. Overall, Nuiqsut harvesters target the highest numbers of resources during the summer/fall months of August and September.

Table F-3: Nuiqsut Annual Cycle of Subsistence Activities

Resources	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Freshwater Non-Salmon	Moderate	Limited	Moderate	Moderate	Limited	Limited	Moderate	High	High	High	High	Limited
Marine Non-Salmon	None	None	None	None	None	None	None	None	High	High	None	None
Salmon	None	None	None	None	None	None	High	Moderate	None	None	None	None
Caribou	Limited	Limited	Limited	Limited	Limited	Moderate	High	High	Moderate	Moderate	Limited	Limited
Moose	Limited	None	None	None	None	None	Limited	High	High	Moderate	Limited	Limited
Bear	Moderate	Moderate	Moderate	Limited	Limited	Limited	Limited	Limited	High	Moderate	Moderate	Moderate
Muskox	None	None	None	None	None	None	None	High	High	High	None	None
Furbearers	High	High	High	High	Moderate	Limited	Limited	Limited	Limited	Limited	Moderate	High
Small Land Mammals	None	None	None	None	Limited	Limited	High	High	Limited	None	None	None
Marine Mammals	None	None	Moderate	High	Limited	Limited	Moderate	High	High	Limited	Limited	Limited
Upland Birds	Moderate	Moderate	High	High	Moderate	Limited	None	Limited	Limited	Moderate	Moderate	Moderate
Waterfowl	None	None	None	Limited	High	High	Moderate	Moderate	Moderate	Moderate	Limited	Limited
Eggs	None	None	None	None	None	High	None	None	None	None	None	None
Plants and Berries	None	None	None	None	Limited	Limited	High	High	None	None	None	None

Key: White = No Activity
Yellow = Limited activity and/or harvests
Orange = Moderate activity and/or harvests
Red = High activity and/or harvests
Notes: Rankings of "High," "Moderate," and "Limited" are based on an analysis of all sources of seasonal round data listed below. For each source, the study team assigned each month a ranking of "1," "2," or "3" based on the intensity of use identified in that source's data set. The study team then summed the individual rankings for each month across all sources, and then assigned a ranking of "1 (Limited)," "2 (Moderate)," or "3 (High)" based on the summed values
Sources: Bacon et al. 2009; Braem et al. 2011; Brower and Hepa 1998; Brown 1979; Brown et al. 2016; EDAW Inc. 2008; Fuller and George 1999 (where resource category data are available); Galginaitis 2014; Hoffman et al. 1988; Libbey et al. 1979; SRB&A 2010a, 2018.

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APPENDIX G

HUMAN HEALTH BASELINE SUMMARY

BASELINE HUMAN HEALTH SUMMARY

GMT2 PROJECT

JULY, 2017

Prepared by:

Alaska Department of Health and Social Services

Environmental Public Health Program

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GMT2 BASELINE HUMAN HEALTH SUMMARY

Introduction

This baseline human health summary presents an overview of the current health status of the communities within the North Slope Borough (NSB). This baseline health summary included Anaktuvuk Pass, Atqasuk, Kaktovik, Nuiqsut, Point Hope, Point Lay, Utqiaġvik [formerly known as Barrow], and Wainwright. This baseline summary refers to these communities as potentially affected communities (PACs) in accordance with the HIA Toolkit (ADHSS, 2015). The summary focused on Nuiqsut because it is the closest PAC to the proposed GMT2 Project.

Baseline health conditions form a fundamental context for the overall health impact assessment (HIA) process. The baseline health summary creates a point of reference for the health status of a community prior to development of a proposed project and also describes an overall health profile for an area. The baseline health summary will inform decision-makers about health vulnerabilities and strengths of PACs. This information, used in conjunction with their knowledge of the features of a project, will help them better understand the potential health implications of the project and better inform deliberations.

For Alaska, baseline health information can be found in public health surveillance systems maintained by the State of Alaska, the Alaska Native Tribal Health Consortium (ANTHC), and occasionally local borough and tribal entities. This document focuses on a review of existing public health surveillance data. The GMT2 Baseline Human Health Summary presents personal health information (PHI) according to the requirements of the Health Insurance Portability and Privacy Act of 1996 (HIPPA). The State of Alaska's approach to PHI is detailed in the HIA Toolkit (ADHSS, 2015).

Alaska public health agencies routinely report public health surveillance data at the statewide or regional level. These agencies do not typically report village or community-level data to avoid privacy violations (e.g., stigmatization) and problems with statistical analysis when case numbers are small. In general, the State of Alaska does not release disaggregated results for small numbers (e.g., <6). As a result, the majority of the data presented in this baseline health summary represents the entire NSB, rather than community-level data.

Baseline community health data are organized and presented by specific Health Effect Categories (HECs). The report focuses on health data that, based on experience with similar types of projects, are likely to be most relevant to the proposed GMT2 Project.

HEC1: Social Determinants of Health

The World Health Organization (WHO) defines the social determinants of health as, "the circumstances in which people are born, grow up, live, work, and age, and the systems put in place to deal with illness" and asserts that "the social determinants of health are mostly responsible for health inequities—the unfair and avoidable differences in health status seen within and between countries" (WHO, 2008).

Both health outcome data and health determinant data are used to establish baseline health status according to the social determinants of health. An outcome is a health event that has actually occurred, while a determinant is a setting or context that strongly influences health status.

Life expectancy, maternal and child health, intimate partner violence and sexual violence, oral health, suicide rates, and substance dependence are health outcomes used as general indicators of physical and social wellness. Family structure, economic status, educational attainment, family stability, and cultural continuity are health determinants that are associated with positive and negative health outcomes. For the purpose of the baseline health summary, regional information about the aforementioned criteria is compared to information for all Alaska Native peoples (AN), Alaskans statewide, and to the U.S. population, where possible.

Demographics

Population

The PACs described in this baseline summary are communities whose residents may be affected by the proposed GMT2 Project. This includes the eight villages of the NSB (Anaktuvuk Pass, Atqasuk, Utqiaġvik, Kaktovik, Nuiqsut, Point Hope, Point Lay and Wainwright). Additional data will be provided, where possible, for the community of Nuiqsut, due to its proximity to the proposed project.

The population of the villages in the PACs is described in Table 1. The majority of villages are small, with populations fewer than 500 residents. The majority of residents in all communities (roughly 90%, except in Utqiaġvik) are American Indian/AN. The population is young (median age: 24-31 years old; Table 1).

Table 1. Population demographics in PACs

Village	Population size	American Indian/Alaska Native[a]	Median age (years)	Proportion of residents ≥ 65 years of age	Proportion of residents < 18 years of age
Anaktuvuk Pass	324	92%	27	4%	33%
Atqasuk	233	93%	24	6%	39%
Kaktovik	239	90%	31	8%	30%
Nuiqsut	402	90%	25	6%	28%
Point Hope	674	93%	25	6%	35%
Point Lay	189	89%	25	4%	31%
Utqiaġvik	4,212	69%	28	5%	33%
Wainwright	556	92%	28	5%	34%

Source: U.S. Census, 2014

[a]Race reported alone or in combination with one or more other races

Income

The U.S. Census Bureau collects data on median household income via the American Communities Survey (ACS). Income includes all monetary sources of income including wages, the Permanent Fund Dividend, corporation dividends, and public assistance (ADCRA, 2016). Income does not include any dollar equivalent of subsistence resources (resources from the harvesting and processing of wild foods and raw materials). For 2014, the estimated median household income in the NSB was $74,609; for Alaska it was $71,829. Median household income in the PACs ranged from $49,375 (Anaktuvuk Pass) to $85,883 (Nuiqsut; Table 2). In the majority of NSB households, permanent fund dividends account for 7-17% of the household's total income. The three most important sources of income for Iñupiat households in the NSB are wage work (57%), corporation dividend income (20%) and permanent fund dividends from the state (NSB Census, 2015)

According to the 2010-2014 ACS estimates, the per capita income in the NSB ($50,267) was one and a half times higher than in the State of Alaska ($33,129). Each PAC had a per capita income lower than the state average, with Utqiaġvik having the highest at $27,696 (U.S. Census ACS, 2014; Table 2).

Employment

Employment is another key demographic factor that influences health. Unemployment includes anyone who has made an active attempt to find work in the four-week period up to and including the week that includes the 12th of the referenced month. Due to the scarcity of employment opportunities in rural Alaska, many individuals do not meet the official definition of unemployed because they are not conducting active job searches. In October of 2016 (the most recently available data), the unemployment rate for the entire NSB was 6.7%, which was similar to the statewide unemployment rate of 6.3%, but higher than the nation-wide rate of 4.7% (ADLWD, 2016). According to the 2015 NSB Census, the unemployment rate for the NSB was 27.7%; this rate was determined through interviews and census respondents, rather than from unemployment insurance claims and accounts for the lack of employment opportunities and seasonal unemployment in the NSB. Communities outside of Utqiaġvik bear the largest burden of unemployment in the NSB (NSB Census, 2015).

Percent living below poverty level

Poverty is a powerful determinant of human health (Braveman et al., 2011). The U.S. Census Bureau uses a set of money income thresholds that vary by family size and composition to determine who is in poverty nationwide (U.S. Census, 2016). However, the U.S. Census defines poverty in a way that does not take into account the higher cost of living in Alaska. The U.S. Department of Health and Human Services adjusts poverty guidelines for entitlement programs such as Women, Infants and Children, and Temporary Assistance for Needy Families for local factors. For the 48-contiguous U.S. states, the 2016 poverty level for a 1-person household was $11,880 and for a 4-person household it was $24,300. Comparatively, the 2016 poverty level in Alaska for a 1-person household was $14,840 and for a 4-person household was $30,380 (ASPE, 2016). However, the poverty measure may still not accurately predict the well-being of a family in rural Alaska, due to the contributions from subsistence and sharing resources within the community (Goldsmith, 2007; Kofinas et al., 2016).

In 2014, the percent of residents living below the federal poverty level in the NSB was very similar to the percentage for all of Alaska (10.2% for NSB, 10.1% for Alaska; Table 2). The variation between villages is

high, ranging from 3% in Nuiqsut to over 21% in Atqasuk. All villages, except Nuiqsut, had a higher percentage of residents living below the poverty line than the State of Alaska as a whole (U.S. Census ACS, 2014).

Table 2. Economic indicators

Location	Per Capita Income ($)	Median Household Income ($)	% of People Living Below the Poverty Limit
State of Alaska	33,129	71,859	10.1%
North Slope Borough	50,267	74,609	10.2%
Anaktuvuk Pass	19,122	49,375	18.9%
Atqasuk	19,968	51,500	21.5%
Kaktovik	20,782	58,125	14.8%
Nuiqsut	26,861	85,833	3.0%
Point Hope	19,497	67,500	11.9%
Point Lay	18,819	60,000	16.7%
Utqiaġvik	27,696	82,976	12.3%
Wainwright	20,551	64,861	19.3%

Source: U.S. Census ACS, 2014

Educational attainment

The highest level of household educational attainment is positively associated with improved overall family health status (Muennig, 2006). High school graduates have been found to live an average of 6 to 9 years longer than high school dropouts (Wong et al., 2002). Adults with low educational attainment are more likely to die from cardiovascular disease, cancer, and lung disease (Muennig, 2005). Multiple mechanisms have been proposed to account for this trend. Education positively impacts lifestyle choices and health-related decisions, and better-educated people are also less likely to be employed in dangerous jobs (Muennig, 2006).

Compared to the State of Alaska, the NSB has a slightly lower percentage of adults with a high school diploma and with a bachelor's degree or higher (Table 3). The percentage of adults who are high school graduates varies considerably among the communities, from a low of 69.7% in Atqasuk to a high of 82.7% in Utqiaġvik (U.S. Census ACS, 2014).

Table 3. Educational attainment

Location	Percent high school graduate or higher
Alaska	91.8%
North Slope Borough	87.1%
Anaktuvuk Pass	75.4%
Atqasuk	69.7%
Utqiaġvik	82.7%
Kaktovik	70.4%
Nuiqsut	70.4%
Point Hope	81.5%
Point Lay	80.0%
Wainwright	75.2%

Source: U.S. Census ACS, 2014

General Health

Self-rated health is one of the most consistent predictors of illness, premature death, health care utilization, and hospitalization. In 2010, more than three-quarters (79%) of Nuiqsut heads of household reported their health to be at least good, and 21% reported fair to poor health, which is generally consistent with the other NSB villages. The percentage of adults reporting to have very good to excellent health was lower in Nuiqsut (39%) than it was statewide (56%; BLM, 2013). Comparatively, in 2015, 95% of Nuiqsut heads of household reported their health to be at least good. With the exception of Anaktuvuk Pass, the percentage of household heads reporting poor to fair health in all NSB communities decreased (NSB Census, 2015).

Maternal and Child Health

Infant mortality

Infant mortality is an important indicator for population health and is influenced by living conditions, food security, domestic conflict, socio-economic well-being, and access to health services. Infant mortality can be separated into neonatal deaths, which occur during the first 28 days of life, and post-neonatal deaths, which occur from the 28th day to 1 year of life. Whereas neonatal deaths are associated with the quality of prenatal and perinatal health care, post-neonatal deaths are more closely associated with socio-economic conditions (AMAP, 2009).

The infant mortality rate in the NSB (11.6 per 1,000 live births) was 2 times higher than the rate for the State of Alaska (5.7 per 1,000 live births) from 2011-2015. In 2014, the infant mortality rate for the U.S. was 5.8 deaths per 1,000 live births. These data suggest that the post-natal experience, which is affected by socio-economic conditions, is of concern in the NSB compared to Alaska overall and the U.S., though it is important to note that infant mortality rates in the NSB have been declining in recent decades (NSB, 2012).

Low birth weight

Low birth weight is defined by the WHO as a weight at birth of less than 2,500 grams (5.5 lbs) and most often results from poor delivery of nutrients and oxygen to the fetus, which is directly related to the

health of the mother (WHO, 2005). Low birth weight is associated with an increased risk of lifelong disability and a 20-fold increased risk of premature death (NCHS, 2011). Low birth weight is therefore an indicator of health in maternal and infant populations.

In 2015, the percent of low birthweight infants (all races) in the NSB was 6.4%, compared to 5.7% low birthweight infants statewide. The percent of low birthweight infants in the NSB has remained relatively stable and comparable to Alaska rates since 1995 (NSB, 2014).

Substance use during pregnancy

Substance use during pregnancy refers to the consumption of alcohol, tobacco, and/or drugs while pregnant. Substance use is a risk for both the mother and the fetus and can lead to premature detachment of the placenta, sudden infant death syndrome, and developmental problems in childhood (WHO, 2005). Alcohol use during pregnancy puts infants at risk for fetal alcohol spectrum disorders (FASD), the leading preventable cause of birth defects and developmental disabilities nationwide (CDC, 2011).

In the NSB during 2012, the percentage of infants born to all mothers who reported drinking alcohol (0.6%) during pregnancy was much less than that reported for Alaska mothers statewide (2.6%; ABVS, 2015). The NSB Baseline Community Health Analysis (NSB, 2012) reported that the prevalence of FASD in the NSB was >3 times the state average and 16 times the rate in non-Natives statewide, but was similar to the rate for AN statewide. Variation in screening practices, diagnosis, and reporting may account for some of the regional differences (NSB, 2012).

Smoking during pregnancy is the single most important contributor to low birth weight (CDC, 2004). In the NSB in 2015, 47.8% of infants were born to mothers who reported smoking during pregnancy. This was almost 3 times higher than the statewide rate of 18.5% (ABVS, 2016).

Mental Health

Mental health is a "state of well-being in which an individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively, and is able to make a contribution to his or her community (WHO, 2014)". Mental health, or behavioral health, is increasingly considered a critical component of overall health and is linked to physical health and well-being for people at all ages. Mental health can be affected by factors such as employment, working conditions, income, living environment, housing quality, food security, physical health, and cultural support (NSB, 2014).

Assessing mental health at the population level is often challenging, in part because diagnosis can be low (e.g., people may not seek medical care for depression). Also, Iñupiat cultural traditions sometimes prevent the open recognition and discussion of emotional suffering (NSB, 2012). These factors can result in under reporting and diagnosis of mental health issues. Often, researchers must rely on self-reported data to gain a clearer picture of mental health in a community.

Mentally unhealthy days

The Behavioral Risk Factor Surveillance System (BRFSS) asked participants 'thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?'. From 2011-2013, NSB residents (all races) reported 3.3

mentally unhealthy days per month, compared to 3.1 mentally unhealthy days reported statewide. NSB residents reported fewer mentally unhealthy days than AN statewide (4.0 days) and all Alaskans (3.2 days). The average number of mentally unhealthy days in the NSB has more than doubled from a low of 1.5 days in 1995-1997 (BRFSS, 2016). Additionally, from 2008-2010, residents in the NSB less commonly reported always or usually receiving the social and emotional support they needed (53%) than AN statewide (66.8%) or all Alaskans (80.0%; NSB, 2012).

Suicide

Suicide is an important health outcome that can indicate mental health illness in a population and has devastating effects on families and communities. Age-adjusted suicide mortality rates are consistently higher in the NSB compared to the State of Alaska (NSB, 2014). Suicide was the fifth leading cause of death in the NSB and the sixth leading cause of death in the State of Alaska from 2013-2015. The age-adjusted suicide rate in the NSB from 2013-2015 (30.1per 100,000 U.S. year 2000 standard population) was similar to the age-adjusted rate for the State of Alaska (24.2 per 100,000 U.S. year 2000 standard population), though it is important to note that the NSB rate was based on fewer than 20 occurrences and may therefore be statistically unreliable and should be interpreted with caution. Suicide has remained a leading cause of death in the NSB for over 2 decades, ranked as either the fourth or fifth leading cause of death since 1992 (ABVS, 2015).

Substance Dependence

Substance abuse is an indication of poor mental health, can cause additional health problems, and strongly influences many related health outcomes, such as accidents and injuries, suicide, and mental health. Substance abuse includes illicit use of drugs (such as marijuana and heroin), alcohol addiction, and binge drinking. Current substance use is defined as having used (e.g., alcohol, marijuana, or cocaine) in the past 30 days.

According to the NSB 2010 Census, 33% to 57% of household heads reported that they felt a household member had been hurt often by the effects of drugs or alcohol in the previous year. This illustrates the wide-ranging effects of alcohol and drug abuse on the individual, household, and community levels (NSB, 2012).

Alcohol

Alcohol abuse is linked to chronic disease, risky and violent behavior, injuries, suicide, homicide, disintegration of family structure and well-being, and adverse home environments for children. In particular, interpersonal violence and injury are associated with "binge," or episodic, heavy drinking (WHO, 2006; IAP, 2013). Binge drinking is defined as a pattern of drinking that brings a person's blood alcohol concentration to 0.08 grams percent or above. Typically, this happens when men consume 5 or more drinks, and when women consume 4 or more drinks, in about 2 hours (CDC, 2015).

In the NSB, 34% of all injury hospitalizations, and 63% of assault injuries among AN were recorded as alcohol-related (NSB, 2012). According to BLM 2013, "alcohol is involved in an estimated 40% of snow machine-related injury hospitalizations, 70% of assault injuries, 57% of suicide attempts, and 45% of motor vehicle-related injury hospitalizations" (BLM, 2013).

According to data from the Alaska BRFSS, from 2011-2013, the self-reported prevalence of current alcohol use was lower in the NSB (37.4%) than among AN statewide (43.4%) and among all Alaskans (56.6%). For that time period, the NSB had one of the lowest self-reported prevalences of current alcohol use when compared to other regions in the state. Also for the same time period, the self-reported prevalence of binge drinking in the NSB (20.1%) was similar to the binge drinking prevalence for all AN statewide (20.3%) and for all Alaskans (18.6%; BRFSS, 2016).

Marijuana

In 2015, current marijuana use among high school students was higher in the Northwest region (35.7%; includes NSB, Northwest Arctic Borough, and the Nome Census Area) than high school students statewide (26.1% AN statewide, 19.0% all Alaskans statewide; BRFSS, 2016). Marijuana use statistics for adults at the regional level are limited.

Tobacco

Tobacco use and exposure to second-hand smoke have been associated with many different health conditions, including lung cancer and heart disease (CDC, 2016). Rates of tobacco use in NSB are very high compared to most other areas of Alaska, with almost half of adults engaged in regular smoking. From 2011-2103, the NSB had the third-highest prevalence of current tobacco users (includes current smokeless tobacco users). The prevalence of current tobacco users in the NSB from 2011-2012 was 53% (BRFSS, 2016). The 2015 NSB census also found that 53% of the Iñupiat population reported smoking as least some days each week (NSB Census, 2015). Comparatively, 46.5% of AN statewide and 26.1% of all Alaskans reported current tobacco use (BRFSS, 2016). Adolescents in the Northwest region also had a high prevalence of current smokers. In 2015, 24.1% of high school students in the Northwest region reported smoking a cigarette in the past 30 days. Comparatively, 19.7% of AN HS students statewide and 11.1% of all high students statewide reported current cigarette-smoking status (BRFSS, 2016).

Cultural Continuity

Cultural continuity has been linked to numerous positive health outcomes, including reduced rates of suicide (Chandler, 1998; Chandler, 2004). Speaking a native language and participating in subsistence activities have been highlighted by circumpolar communities as important signifiers of community health and cultural continuity (Stevenson, 2009). Subsistence participation can include use of subsistence resources, harvest activities, sharing, and receiving subsistence resources.

In 2014, 34% of NSB residents spoke a language other than English at home (most commonly Iñupiaq; range: 36-58%). For that same year, 58% of Nuiqsut residents reported speaking a language other than English at home (U.S. Census ACS, 2014).

Participation in subsistence preserves cultural continuity and ensures cultural survival. Participation in subsistence activities is high throughout the region; in 2015, nearly 99% of households in all NSB communities participated in subsistence activities and at least 95% of NSB Iñupiat households reported consuming subsistence foods (NSB Census, 2015).

Summary

Areas of Vulnerability

- The per capita income of residents in the PACs is lower than the per capita income of the state.
- All villages, except Nuiqsut, had a higher percentage of residents living below the poverty line than the State of Alaska as a whole.
- Infant mortality rate is higher in the NSB. Even though infant mortality is steadily decreasing in the state, prenatal care remains a critical topic in the NSB.
- A greater percentage of women in the NSB reported smoking during pregnancy than in the state.
- Prevalence of smoking is higher in the NSB than most regions in the state.

Areas of Resilience/Success

- Self-reported prevalence of heavy drinking and binge drinking in the NSB is lower than most regions in the state.
- All NSB communities exhibit a high level of participation in subsistence harvests and other subsistence activities (such as sharing and receiving subsistence resources).

HEC 2: Accidents and Injuries

Accidents and Injuries are an important cause of morbidity and mortality in Alaska. The term unintentional injury refers to causes of injury or death other than suicide and homicide. Fatal injury information is drawn from death certificates and the Alaska Violent Death Reporting System (VDRS), while non-fatal injuries are typically obtained from the Alaska Trauma Registry (ATR).

Fatal Injuries

Fatal unintentional injuries

From 2013-2015, unintentional injuries were the third leading cause of death among all residents of the NSB and among Alaska residents statewide. Motor vehicle accidents were the leading cause of unintentional injury death in the NSB (6 deaths), followed by poisoning (5 deaths), which is typically caused by alcohol ingestion, though an age-adjusted rate was not reported due to the small number of cases. Poisoning was the leading cause of unintentional injury death statewide, followed by motor vehicle accidents (Table 4; ABVS, 2016).

Table 4. Unintentional Injury Deaths by Cause, North Slope Borough and State of Alaska, 2013-2015

Cause of Death		North Slope Borough		State of Alaska	
		Number of Deaths	Age-adjusted Rate[a]	Number of Deaths	Age-adjusted Rate[a]
Unintentional Injuries		**15**	**68.2***	**1117**	**54.7**
Transport accidents	Motor vehicle accidents	6	22.4*	228	10.2
	Snow machine[b]	2	**	23	0.9
	ATV[c]	1	**	40	1.7
Nontransport accidents	Falls	0	**	113	7.2
	Poisoning	5	**	398	18.1

Source: ABVS, 2016
[a] Age-adjusted rates are per 100,000 U.S. year 2000 standard population
[b] Deaths to an operator or passenger related to the use of a snow machine
[c] Deaths to an operator or passenger related to the use of an ATV
* Rates based on fewer than 20 occurrences are statistically unreliable and should be used with caution
**Rates based on fewer than 6 occurrences are not reported

Fatal intentional injuries (suicide)

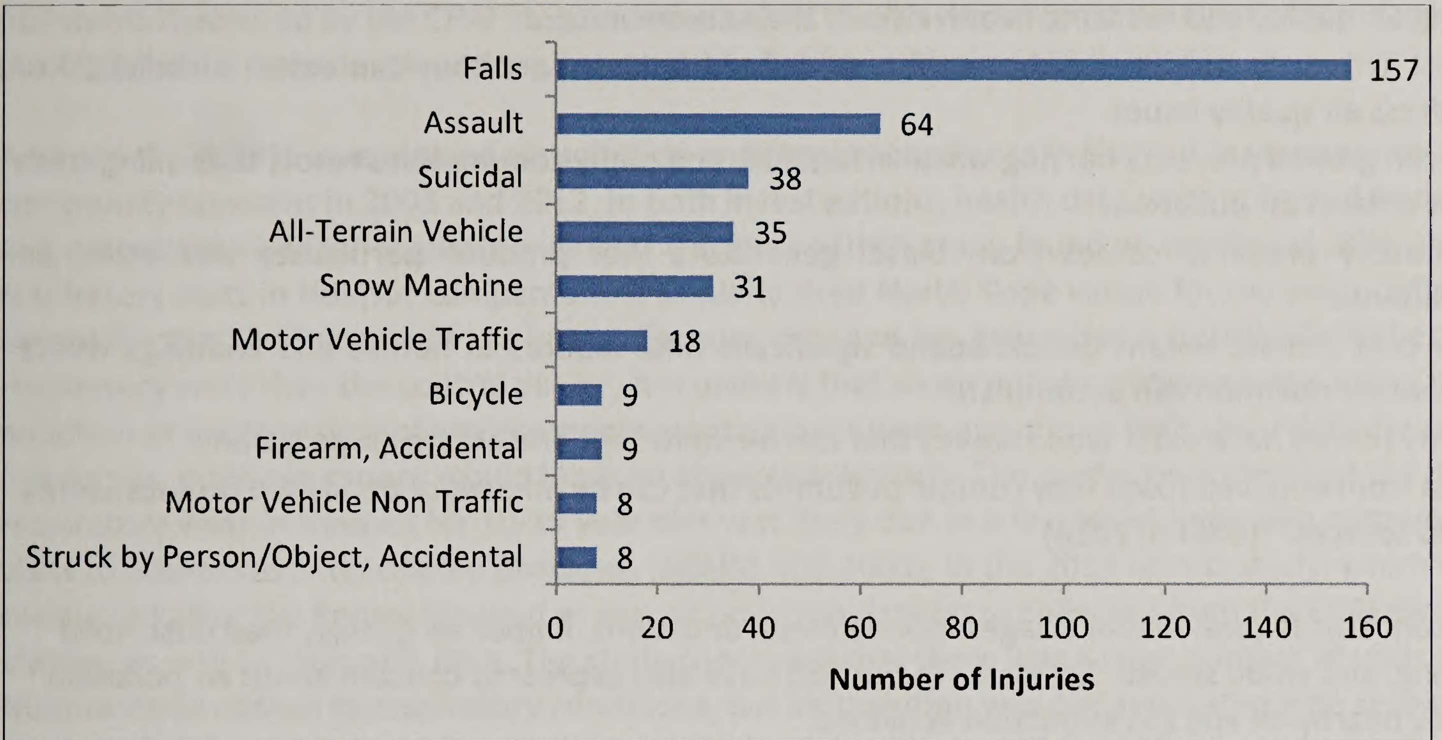
Suicide was the fifth leading cause of death in the NSB from 2013-2015 (ABVS, 2016). Suicide has remained a leading cause of death in the NSB for over 2 decades. More than two-thirds of suicides occurring in the NSB since 2000 have involved firearms (NSB, 2012).

Non-fatal injuries

According to the NSB Baseline Community Health Analysis Report, from 1999-2008, there were 736 non-fatal injury hospitalizations among NSB residents. The leading causes of injury hospitalization for this time period were falls, suicide attempts, assault, and snow machine-related injuries. With the exception of motor vehicle traffic-related injuries, injury hospitalization rates in the NSB were higher than the statewide rates. In particular, the NSB rate of snow machine-related injury hospitalizations was four times higher than the statewide rate for all Alaskans and twice as high as the rate for AN statewide (NSB, 2012).

The Alaska Trauma Registry (ATR) records non-fatal injuries that are serious enough to require admission to a health care facility. According to the ATR data, from 2009-2015, the most common cause of non-fatal injury requiring hospitalization in the NSB was falls (35% of all non-fatal injuries), followed by assault (14%), and attempted suicide (8%). These three causes of injury alone accounted for 57% of all non-fatal injuries from 2009-2015 (Figure 1). Males accounted for 57% of all injuries in this time period (ATR, 2016).

Figure 1. Leading causes of North Slope Borough non-fatal injury hospitalizations, 2009-2015



Source: ATR, 2016
* Starting 1/1/2013: Adults (18 years and older) were no longer included in the ATR due to intentional, self-inflicted, suicidal overdoses

Summary

Areas of Vulnerability

- Accidents and injuries were the third leading cause of death in the NSB from 2013-2015. The most common causes of unintentional injury deaths among all NSB residents were motor vehicle accidents (the majority of which are snow machine accidents) and poisoning (typically caused by alcohol ingestion).
- Falls, assaults, and suicide attempts were the most common causes of non-fatal injury hospitalization in the NSB from 2009-2015.

HEC 3: Exposure to Potentially Hazardous Materials

When reviewing data on exposure to potentially hazardous materials, it is important to consider health outcomes, such as the prevalence of illnesses that result from exposures to hazardous materials (including asthma and cancer), and health determinants, such as soil, water, and air quality (when data are available).

Air Quality—Expanded Discussion

Air pollution has been shown to increase the risk of a number of respiratory and cardiac conditions. Air pollution is also associated with increased daily mortality rates (Dockery et al., 1993). The elderly, children, and those with underlying health problems are particularly vulnerable to the effects of air pollution (CDC, 2016b).

According to the U.S. Environmental Protection Agency (USEPA), "tribes in Alaska face unique challenges to protecting air quality and reducing health risks in their communities:

- Most Tribes do not have a reservation or defined lands where they can assert jurisdiction to address air quality issues.
- Frozen ground prevents burying waste in landfills, and many communities resort to burning trash that creates air pollution.
- Electricity primarily comes from diesel generators that produce particulate and other air pollutants.
- The cold climate means people spend significant time indoors in homes and buildings where indoor air pollution can accumulate.
- Many homes have older wood stoves that can be inefficient and create air pollution.
- Dust from unpaved roads may contain pollutants that can be inhaled or deposited on subsistence food sources." (USEPA, 2016)

Air quality concerns in rural Alaska villages include diesel emissions, indoor air quality, road dust, solid waste burning, and wood smoke. Residents in the NSB have also expressed concern about air pollution generated by nearby oil and gas extraction activities.

In response to concerns about air pollution generated from oil and gas extraction activities, the Alaska Native Tribal Health Consortium (ANTHC) partnered with the Native Village of Nuiqsut to conduct an independent assessment of the air quality in Nuiqsut. The study included a review of 2008-2010 air monitoring data from the ConocoPhillips Alaska, Inc. (CPAI) air monitoring station. This station is located on the northern edge of Nuiqsut, 6 miles east of the Alpine Central Processing Facility (which processes oil and natural gas from the surrounding production pads), and collects data on the following pollutants: carbon monoxide (CO), nitrogen oxides (NO_x), ozone (O_3), sulfur dioxide (SO_2), particulate matter ≤10 μm (PM_{10}), and particulate matter ≤2.5 μm ($PM_{2.5}$). Data from the air monitoring station showed pollutant concentrations generally well below the national ambient air quality standards (NAAQS). PM_{10} exceeded the 24-hour average NAAQS twice from 2008-2010 and both instances were believed to be caused by dust from natural sources. $PM_{2.5}$ exceeded the 24-hour NAAQS once from 2008-2010 and may have been due to a large forest fire plume. CO, NO_x, O_3, and SO_2 all remained below the NAAQS from 2008-2010 (ANTHC, 2011).

Researchers also collected air and water samples to assess for volatile organic compounds (VOCs). Of the 45 samples collected, 28 contained VOCs, though none of the VOC concentrations exceeded the air quality standards and screening levels set by multiple federal agencies (U.S. Environmental Protection Agency, Agency for Toxic Substances and Disease Registry, National Institute for Occupational Safety and Health, and Occupational Safety and Health Administration). VOCs specifically associated with crude oil development were either not detected or were found at very low concentrations (below all standards and screening levels) for all of the collected samples. None of the water samples had VOC concentrations that exceeded the ADEC water quality standards (ANTHC, 2011).

The most frequently identified source of air pollution during key informant interviews in Nuiqsut was oil and gas development (ANTHC, 2011). The available air monitoring data do not support this observation, as measured air pollutant concentrations are consistently low. It will be crucial to continue to monitor air quality in Nuiqsut over time.

In 2013, ADEC reviewed pollutant data from the CPAI Nuiqsut monitoring station. ADEC found that all pollutants measured by the CPAI monitor were below the Alaska Ambient Air Quality Standards (AAAQS), which were developed to protect public health in Alaska (ADEC, 2015).

Additionally, ADHSS investigated air pollution and respiratory illness in Nuiqsut in response to community concerns in 2003 and 2012. In both investigations, health data were collected from inpatient and outpatient visits for respiratory illness. The 2003 ADHSS study found no significant differences for respiratory visits in Nuiqsut compared to a similarly sized North Slope village for the years 1998-2002, except for the 10-19 years old age group. Because only one age group had a statistically higher rate of respiratory visits than the control village, it is unlikely that an air pollution source is the cause. If air pollution or another type of environmental contaminant were associated with clinic visits for respiratory conditions, most age groups would likely be impacted similarly. The study concluded that the increase in respiratory visits in Nuiqsut for 10-19 year olds was likely due to a few individuals with numerous clinic visits to address asthma-related problems (ADHSS SOE 2003). In the 2012 ADHSS study, which was conducted after the Repsol blowout event, air pollution data were collected from the CPAI monitoring station, as well as clinic visit data. The study concluded that there was a large number of visits to the Nuiqsut clinic related to respiratory conditions, but air pollution was not associated with respiratory illness in this investigation; instead, the increase in clinic visits was likely due to increased influenza and respiratory syncytial virus (RSV) activity, which was reported throughout the state during the same time period (ADHSS SOE, 2003; ADHSS SOE, 2012).

Water Quality

Overall, available water quality data for Nuiqsut indicate that, with few exceptions, water quality standards for human consumption are being met (BLM, 2014). See HEC 6: Water and Sanitation for a related discussion on water and sanitation in the NSB.

Summary

Areas of Vulnerability

- Residents of Nuiqsut have expressed concerns that the air quality in the community is poor, and have indicated that this is causing high rates of respiratory diseases; the available air monitoring data do not support this observation, as measured air pollutant concentrations are consistently low. It will be crucial to continue to monitor air quality in Nuiqsut over time.

Areas of Resilience/Success

- Available air quality monitoring data indicate that pollutants are at levels that are not expected to cause adverse health outcomes.
- Results indicate little evidence of significant air- or water-quality problems associated with oil and gas development.

HEC 4: Food, Nutrition, and Subsistence

The Alaska Federation of Natives (AFN) describes subsistence as "the hunting, fishing, and gathering activities, which traditionally constituted the economic base of life for Alaska's Native peoples and which continue to flourish in many areas of the state today" (AFN, 1993).

Subsistence is part of a rural economic system, called a "mixed, subsistence-market" economy, wherein families invest money into small-scale, efficient technologies to harvest wild foods. Fishing and hunting for subsistence resources provides a reliable economic base for many rural regions. Subsistence is focused toward meeting the needs of families and small communities. Participants in this mixed economy in rural Alaska often augment their subsistence production by cash employment. Cash (from commercial fishing, trapping, or wages from public sector employment, construction, firefighting, oil and gas industry, or other services) provides the means to purchase the equipment, supplies, and fuel used in subsistence activities. The combination of traditional and commercial-wage activities provides the economic basis for the way of life valued in rural communities (Wolfe and Walker, 1987).

Subsistence fishing and hunting are important sources of employment and nutrition in almost all rural communities. Traditional fishing, hunting, and gathering are critical sources of nutrition for many residents in areas of Alaska where food prices are high. While some people earn income from employment, these and other residents rely on subsistence to supplement their diets throughout the year. Furthermore, traditional and cultural activities support a healthy diet, cultural continuity, and contribute to residents' overall well-being (Ballew et al., 2004; Kofinas et al., 2016).

Food Security

Food security is defined by the Food and Agricultural Organization of the United Nations as "a situation that exists when all people at all times have physical, social, and economic access to sufficient, safe, nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 2002). Food security is based on the availability, access (both physical and economical; also includes access via sharing networks), and use of food, and is related to health through malnutrition. Food insecurity, the inability to access enough food at all times to meet basic needs, is tied to poor health status among children, including: more frequent colds, ear infections, and other health problems; aggression, hyperactivity, and anxiety; increased need for mental health services; impaired cognitive functioning, lower test scores, and poorer overall school achievement (NSB, 2012; ADHSS, 2008). Food insecurity is associated with malnutrition and is also associated with increased obesity and diabetes because those who do not always have enough food often consume high-calorie foods with low nutrient value (ADHSS, 2008).

NSB households, particularly Iñupiat households, reported high levels of food insecurity in the NSB 2015 Census. In the NSB, 37% of household heads reported that there were times last year when they found it difficult to get the food needed to make healthy meals and 25% of household heads reported that there were times in the previous year when household members did not have enough to eat. Food insecurity varied greatly between communities and ranged 9-54% of households (NSB Census, 2015; Table 5).

Statewide and national food insecurity data are not easily comparable with NSB data because the state and national surveys do not ask about subsistence food security or take into account the lack of availability of many foods in remote communities. For reference, in 2010, 10.8% of Alaska households surveyed were found to have some degree of food insecurity, and 4.4% were found to have "very low

food security," with disrupted eating patterns or reduced food intake (USDA, 2010). Although the NSB 2015 census data are not directly comparable with statewide estimates, the results suggest that food insecurity is a serious problem across the NSB and, like other rural areas, exists at levels higher than statewide estimates.

Table 5. Percentage of food insecure households in the NSB, 2015

Community	% of Food Insecure Households
North Slope Borough	24
Anaktuvuk Pass	54
Atqasuk	31
Kaktovik	10
Nuiqsut	9
Point Hope	25
Point Lay	9
Utqiaġvik	25
Wainwright	24

Source: NSB Census, 2015

The Alaska Department of Fish and Game (ADF&G) conducted a harvest study in Nuiqsut during 2015. In the study, which has several questions focused on food security, 12% of Nuiqsut households worried about having enough food at one or more times during 2014. Approximately 26% of households reported that they lacked the resources (i.e., time, money, and equipment) to obtain either subsistence or store-bought foods (ADFG, 2016). In this study, Nuiqsut had a slightly higher percentage of food secure households (90%) and slightly lower very food insecure households (2%), compared to 2014 estimates for the entire state (88% food secure, 4% very food insecure; ADF&G, 2016).

Subsistence Resources

Participation in subsistence

Data from the NSB 2015 Census indicate that there is a high level of participation in subsistence activities in NSB households (nearly 99% in all NSB communities). In 2015, 95% or more of NSB Iñupiat households reported consuming subsistence foods. The 2010 NSB Census found that participation was high among both men and women (Table 6). Subsistence foods also make up a significant portion of food consumed in NSB communities.

Table 6. NSB Iñupiat household head's participation in subsistence activities

Subsistence Activity	Men	Women
Participation in spring whaling	44%	27%
Participate in fall whaling	31%	23%
Hunt sea mammals	55%	17%
Hunt land mammals	69%	30%
Fish	70%	49%
Hunt birds	61%	22%
Gather bird eggs	14%	7%
Pick berries and plants	44%	45%
Share, cook, and process wild foods	79%	82%
Sew skins and clothes	10%	42%
Make sleds and boats	38%	6%
Trap fur bearers	9%	1%

Source: NSB, 2012; NSB Census, 2010

The annual wild food harvest in 2014 for Nuiqsut was approximately 371,992 pounds in useable weight for the entire community, an average of 3,444 pounds per household and 896 pounds per person (ADF&G, 2016). In terms of usable weight, marine mammals provided 46 percent of the harvest while large land animals (29 percent of harvest), non-salmon fish (23 percent of harvest), salmon (1% of harvest), birds and eggs (1 percent of harvest), and berries and edible plants (<1 percent of harvest) contributed the rest. Table 7 shows the resources most commonly used by Nuiqsut households in 2014. Marine mammals and non-salmon fish were particularly important resources for Nuiqsut. In terms of edible weight, marine mammals (bowhead whale; bearded, ringed, and spotted seals) accounted for 46% of the total wild foods harvested. Non-salmon fish (primarily Arctic cisco, broad whitefish, least cisco, Arctic grayling, and burbot) accounted for nearly one quarter of the 2014 Nuiqsut subsistence harvest (ADF&G, 2016).

Table 7. Subsistence resources most commonly used by Nuiqsut households, 2014

Resource	Percentage of households using resource
Bowhead whale	93%
Caribou	90%
Arctic cisco	83%
White-fronted goose	74%
Broad whitefish	72%
Bearded seal	67%
Cloudberry	62%
Ringed seal	52%
Moose	43%
Blueberry	40%

Source: ADFG, 2016

NSB communities also have strong sharing networks for subsistence resources. Typically, about 30% of rural households in Alaska harvest about 70% of subsistence resources used in a community (Wolfe, 2004). A 2015 study found that in two North Slope communities, Kaktovik and Wainwright, only 25% of subsistence resources in a household were from the households' own harvesting efforts, which indicates

substantial sharing of subsistence resources. Strong sharing networks within and between communities are crucial for social, cultural, health, and economic well-being. Strong sharing networks can also encourage community members, such as young adults, to take pride in harvest subsistence resources and participate in the cooperative traditions within their community; this is important for maintaining cultural continuity in a community.

Summary

Areas of Vulnerability

- NSB households, particularly Anaktuvuk Pass, reported high levels of food insecurity. More than one in three NSB household heads reported difficulty getting the food needed to eat healthy meals, and approximately 24% of household heads reported that at times in the previous year, household members did not have enough to eat.

Areas of Resilience/Success

- There is a high level of participation in subsistence activities and sharing subsistence resources among NSB households. Subsistence foods also make up a substantial portion of food consumed in NSB communities. These determinants are crucial to an individual's health and well-being, as well as ensuring cultural continuity within a community.

HEC 5: Infectious Diseases

Reportable communicable (infectious) diseases include infectious and parasitic diseases, such as tuberculosis, viral hepatitis, sexually transmitted infectious (STIs), influenza, and pneumonia.

With the exception of STIs, the number of cases of reportable infectious diseases in the NSB is very low. Because of the small number of cases of reportable infectious diseases each year, reliable prevalence rates for the NSB cannot be calculated for most individual reportable diseases. Trends in reportable infectious diseases in the NSB are generally comparable to those occurring statewide (NSB, 2012).

Reportable communicable diseases were not among the leading causes of death in the NSB. Pneumonia (2 deaths) and septicemia (1 death) were the only causes of death due to infectious diseases, accounting for less than 2% of all deaths from 2011-2013 (ABVS, 2015). No influenza deaths were reported during the same time period.

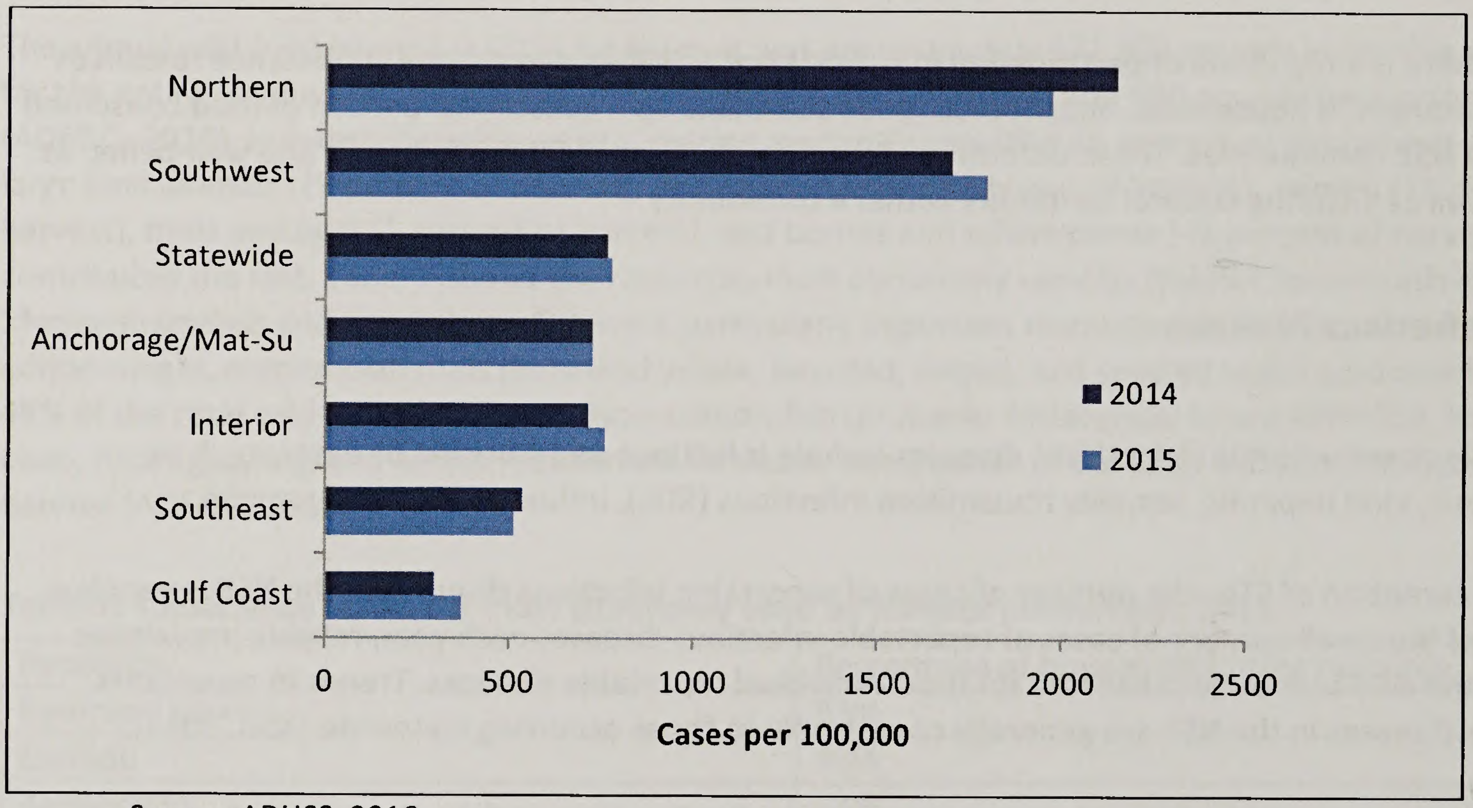
Sexually Transmitted Infections

Chlamydia rates

Chlamydia is a common STI and is caused by the bacterium *Chlamydia trachomatis* (CT). CT can cause pelvic inflammatory disease (PID), ectopic pregnancy, infertility, and preterm labor. Infants born to infected women are at risk for neonatal conjunctivitis and pneumonia. Untreated CT infections in men can cause epididymitis, Reiter syndrome, and infertility.

Alaska ranked first for CT rates nationwide from 2010-2014; rates disproportionately affect northern regions and AN. In 2015, the age-adjusted CT infection rate for the Northern Region (2,151 cases per 100,000 population; includes NSB, Northwest Arctic Borough, and Nome Census Area) was nearly three times higher than the rate statewide (766 cases per 100,000 population) and higher than any other region in Alaska (Figure 2; ADHSS, 2016b).

Figure 2. Chlamydia infection rates, by Region – Alaska 2014 and 2015

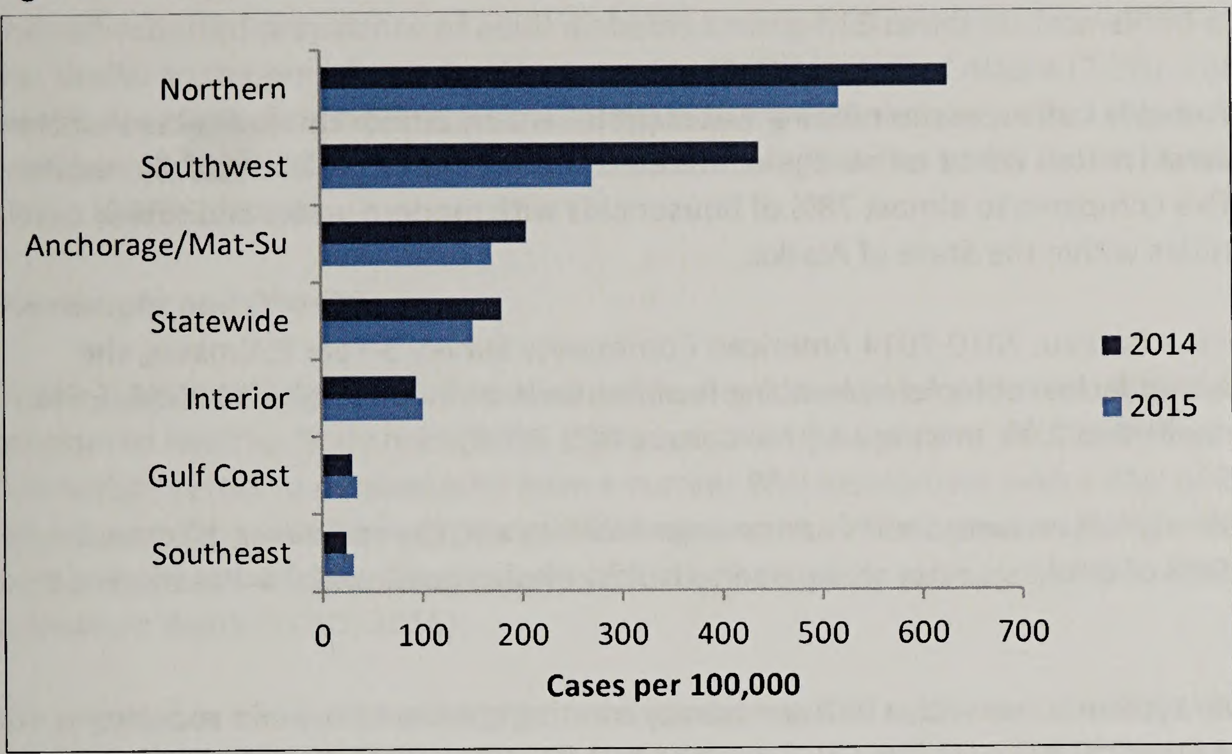


Source: ADHSS, 2016c

Gonorrhea rates

Gonorrhea is an STI caused by the bacterium *Neisseria gonorrhea*. Alaska had the third highest gonococcal infection rate in the nation in 2014 (ADHSS 2016a). The rate of gonorrhea in 2015 was 518 cases per 100,000 population for all races in the Northern Region, which was nearly 3.5 times the rate for Alaska statewide (151 cases per 100,000 population; Figure 3, ADHSS, 2016c).

Figure 3. Gonorrhea infection rates, by Region – Alaska 2014 and 2015



Source: ADHSS 2016c

Summary

Areas of Vulnerability

- The Northern region, which includes NSB communities, is disproportionately affected by chlamydia and gonorrhea.

Areas of Resilience/Success

- The number of cases of reportable, non-STI, infectious diseases in the NSB is very low.

HEC 6: Water and Sanitation

A high proportion of rural Alaska households (approximately 20%) are without basic sanitation facilities and adequate in-home water sources. Relying primarily on community-based water points can lead to inadequate amounts of water collected and increases the likelihood for disease transmission.

The lack of clean running water and proper sewage disposal is a leading cause of preventable diseases in rural Alaskan villages and is directly linked to infectious disease morbidity and mortality. Respiratory, gastrointestinal, and skin diseases are common in areas without safe or easily accessible water supplies.

In a study conducted in 6 regions in Alaska, regions with a lower proportion of in-home water service had 2.5 times the hospitalization rate of pneumonia and influenza and 2 times the rate of skin or soft tissue infection, and over 3 times the rate of respiratory syncytial virus among those younger than 5 years, when compared to higher-service regions (Hennessy et al., 2008).

Water and Sewer Service Rates

In 2015, 92% of NSB households had access to running water (NSB Census, 2015). This indicates that the majority of households drink treated water rather than unfiltered surface water, which typically results in better water quality. This compares to almost 78% of households with modern water and sewer service for rural communities within the State of Alaska.

According to the U.S. Census Bureau, 2010-2014 American Community Survey 5-Year Estimates, the proportion of households that lacked complete plumbing facilities were as follows: 10.6% in NSB, 6.9% in Utqiaġvik, 5.3% in Kaktovik, and 2.0% in Nuiqsut (U.S. Census ACS, 2014).

According to the NSB, 90% of Nuiqsut households had sewage facilities and the remaining 10% used holding tanks. Similarly, 94% of drinking water was piped to Nuiqsut households and 6% was trucked (NSB, 2015).

Nuiqsut's water and sewer system is run with a vacuum pump, creating constant flow and reducing vulnerabilities to freezing pipes. Water operators in 2014 reported few issues with frozen lines. Community water is acquired during an approximate 40-day water making season from July to August, and the water source is a tundra lake located one mile south of town (Brubaker et al., 2014). While water operators noted few issues with freezing pipes, some water and sanitation infrastructure has been impacted by changing permafrost conditions; in 2014, operators reported small-scale permafrost erosion near an outflow pipe from the water tanks. Annual erosion also threatens the sewage outflow line (Brubaker et al., 2014).

Summary

Areas of Vulnerability

- Water and sanitation infrastructure is vulnerable to changing permafrost conditions.

Areas of Resilience/Success

- More than 94% of NSB household have modern water and sewer service.

HEC 7: Non-communicable and Chronic Diseases

Diabetes

Diabetes mellitus is a metabolic disease characterized by high blood sugar levels, which result from defects in insulin secretion, insulin resistance, or both. There are two types of diabetes, Type 1 and Type 2. Type 2 is the most common type of diabetes, is associated with obesity, and is considered a preventable illness. Uncontrolled diabetes can result in serious medical consequences.

From 2011-2013, there were 3 deaths attributed to diabetes in the NSB. Due to the small numbers, an associated rate was not reported. For the same time period, there were 324 deaths related to diabetes mellitus in Alaska (age-adjusted rate of 19.4 per 100,000 U.S. year 2000 population; ABVS, 2015).

The self-reported prevalence of adult diabetes among NSB residents from 2011-2013 was 6.5%, which was similar to the prevalence for AN statewide (7.7%) and all of Alaska (7.2%). Comparatively, the prevalence of prediabetes in adults was higher in the NSB than any other region from 2011-2013. The prevalence of prediabetes in the NSB was 13.3% compared to 10.0% for AN statewide and 8.0% for all of Alaska (BRFSS, 2016).

Overweight and Obesity

Obesity and overweight are terms that define an accumulation of fat that is greater than what is considered healthy. Body mass index (BMI) is a common indicator of obesity and overweight status. Overweight refers to persons who have a current BMI assessment with a BMI of 25 to 29.9 and obese refers to persons who have a current BMI assessment of 30 or greater. Being overweight or obese increases the risk of diabetes, diseases of the heart (mainly stroke and heart disease), cancer, and premature death (WHO, 2016).

The prevalence of adult overweight or obesity among NSB residents from 2011-2013 was 75.8%, which was higher than the prevalence for AN statewide (67.0%) and for all of Alaska (65.0%). NSB had the fifth-highest prevalence of overweight and obesity of all boroughs and census areas in Alaska (BRFSS, 2016). Among NSB communities, the percent of overweight residents ranged from 17%-36% and the percent of obese residents ranged from 23%-48% (Table 8; NSB, 2012).

Table 8. Overweight and obesity among NSB households, 2012

Location	Overweight	Obese
Anaktuvuk Pass	32%	23%
Atqasuk	26%	38%
Kaktovik	34%	32%
Nuiqsut	28%	33%
Point Hope	29%	48%
Point Lay	17%	46%
Utqiaġvik	34%	40%
Wainwright	36%	41%
North Slope Borough	33%	39%
Alaska	37%	28%

Source: NSB, 2012

Cancer

The prevalence of self-reported cancer in the NSB was lower than the prevalence statewide from 2011-2013. For this time period, the prevalence of cancer in the NSB was 3.6% compared to 6.7% for AN statewide and 8.0% for all of Alaska (BRFSS, 2016). The NSB had the second lowest self-reported cancer prevalence of Alaska boroughs and census areas.

During 2013-2015, cancer was the leading cause of death among NSB residents and among Alaskans statewide. Table 9 presents data from the Alaska Bureau of Vital Statistics that shows the age-adjusted rates for cancer deaths in the NSB are higher than those in the state as a whole. Lung cancer was the leading cause of death due to cancer (50.8 deaths per 100,000 persons, though this rate is based on small numbers and should be interpreted with caution; ABVS, 2016).

Table 9. Cancer Deaths by Type, North Slope Borough and the State of Alaska, 2013-2016

Cause of Death	North Slope Borough		State of Alaska	
	Number of Deaths	Age-Adjusted Rate[1]	Number of Deaths	Age-Adjusted Rates[1]
Malignant Neoplasms	**44**	**327.8**	**2942**	**159.5**
Lip, Oral Cavity, and Pharynx	0	0	41	1.9
Esophagus	1	**	94	5.0
Stomach	7	23.7*	89	4.6
Colon, Rectum, and Anus	9	30.4*	273	15.0
Liver and Intrahepatic Bile Ducts	2	**	143	6.5
Pancreas	1	**	195	10.3
Larynx	0	0	12	0.6*
Trachea, Bronchus, and Lung	15	50.8*	765	41.4
Skin	0	0	49	2.8
Breast [2]	2	**	195	19.6
Cervical[2]	1	**	19	1.6
Uterine[2]	0	0	36	3.6
Ovarian[2]	1	**	58	5.7
Prostate[2]	1	**	126	17.8
Kidney and Renal Pelvis	0	0	79	4.5
Bladder	0	0	54	3.3
Brain	0	0	74	3.5
Lymphoid & Hematopoietic	2	**	236	13.5
Hodgkin's Disease	0	0	2	**
Non-Hodgkin's Lymphoma	0	0	86	4.9
Leukemia	2	**	91	5.3
Multiple Myeloma	0	0	56	3.0
All Other Lymphoid & hematopoietic	0	0	1	**
All Other and Unspecified Cancers	3	**	404	22.5

Source: ABVS, 2016

[1]Age-Adjusted rates are per 100,000 U.S. year 2000 standard population

[2] Breast, cervical, uterine and ovarian cancer rates are for females only and prostate cancer rates are for males only

* Rates based on fewer than 20 occurrences are statistically unreliable and should be used with caution

**Rates based on fewer than 6 occurrences are not reported

Cardiovascular and cerebrovascular disease mortality

The prevalence of self-reported diseases of the circulatory system (heart attack, angina, or stroke) in the NSB has consistently been lower than the prevalence statewide. In 2011-2013, the prevalence of cardiovascular disease was 4.2% compared to 5.8% for all of Alaska (BRFSS, 2016). When circulatory diseases were further categorized as heart attack, stroke, cardiovascular disease, or coronary disease, the prevalence was still lower in the NSB compared to statewide (BRFSS, 2016).

The mortality rate of major cardiovascular diseases from 2011-2013 was slightly lower in the NSB than all of Alaska (Table 10; ABVS, 2015).

Table 10. Major Cardiovascular Disease Deaths, North Slope Borough and the State of Alaska, 2011 - 2013

Cause of Death	North Slope Borough		State of Alaska	
	Number of Deaths	Age-Adjusted Rate[1]	Number of Deaths	Age-Adjusted Rate[1]
Major Cardiovascular Diseases	20	165.8	2866	189.9
Heart disease	14	84.7*	2146	137.7
Ischemic heart disease	7	24.8*	1225	74.3
Acute myocardial infarction	0	0.0	246	15.7
Atherosclerotic cardiovascular disease	5	**	450	22.8
All other ischemic heart disease	2	**	529	35.9
All other heart disease	7	60.0*	921	63.4
Cerebrovascular disease	5	**	544	40.4
All other cardiovascular diseases	1	**	176	11.8

Source: ABVS, 2015

[1] Age-adjusted rates are per 100,000 U.S. year 2000 standard population

* Rates based on fewer than 20 occurrences are statistically unreliable and should be used with caution

**Rates based on fewer than 6 occurrences are not reported

Chronic respiratory disease rates

Historically, chronic respiratory diseases have been a major cause of morbidity and mortality in rural Alaska, and respiratory problems remain a frequently cited health concern in NSB communities. The NSB 2010 Census asked household heads whether they or other household members had, in the last 12 months, experienced any breathing problems such as asthma, emphysema, or a cough that does not go away. Thirteen percent of household heads and 8% of all adults in the NSB reported or were reported to have experienced any of these problems. The estimated prevalence of these respiratory problems did not vary significantly by ethnic group, gender, or community of residence. Of children aged 0–17 years, 5% were reported by the household head to have had breathing problems such as asthma, emphysema, or a chronic cough in the past 12 months. There was not a statistically significant difference in the relationship between village of residence and the prevalence of breathing problems among children (NSB, 2012).

Chronic lower respiratory disease mortality

Chronic lower respiratory disease (such as asthma or emphysema) is one of the most frequently stated concerns in the NSB. In the NSB, chronic lower respiratory disease has been the fourth or fifth leading cause of death for most years since at least 1992, which is comparable to the state of Alaska in recent years. From 2013-2015, the age-adjusted chronic lower respiratory disease mortality rate was higher in the NSB compared to the rate statewide (Table 11). However, the NSB mortality rates were based on fewer than 20 deaths, and should therefore be interpreted with caution as the rate may be statistically unreliable (ABVS, 2016).

Table 11. Chronic lower respiratory disease rates, NSB, 2013-2016

Detailed Cause of Death	NSB Deaths	Crude Rate[1]	Age-Adjusted Rate[2]	Alaska Deaths	Alaska Crude Rate[1]	Alaska Age-Adjusted Rate[2]
Chronic lower respiratory disease	11	37.2*	129.0*	593	26.8	37.2

Source: ABVS, 2016

[1] Crude rates are per 100,000 population

[2] Age-adjusted rates are per 100,000 U.S. year 2000 standard population

* Rates based on fewer than 20 occurrences are statistically unreliable and should be used with caution

Asthma

Asthma is a disease that affects the lungs and can cause repeated episodes of wheezing, breathlessness, chest tightness, and nighttime or early morning coughing (CDC, 2016a). There are multiple environmental factors known to trigger or exacerbate asthma symptoms, including tobacco smoke, exhaust from heating sources and vehicles, and poor air quality (both outdoor and indoor air). Indoor air pollution is a particular concern in rural Alaska, primarily due to tightly sealed houses with inadequate ventilation and prolonged time spent indoors (NSB, 2012).

The prevalence of self-reported asthma ('Have you ever been told by a doctor, nurse, or other health professional that you have asthma?') has consistently been lower in the NSB than the prevalence statewide. In 2011-2013, the prevalence of asthma was 9.7% compared to 14.4% of for all of Alaska (BRFSS, 2016).

In response to community concerns about asthma and pollution from nearby oil and gas development activities, ADHSS investigated air pollution and respiratory illness in Nuiqsut in 2003. The 2003 ADHSS study found no significant differences for respiratory visits and asthma in Nuiqsut compared to a similarly sized North Slope village for the years 1998-2002, except for the 10-19 years old age group. Because only one age group had a statistically higher rate of respiratory visits than the control village, it is unlikely that an air pollution source is the cause. If air pollution or another type of environmental contaminant were associated with clinic visits for respiratory conditions, most age groups would likely also see increased rates of respiratory visits. The study concluded that the increase in respiratory visits in Nuiqsut for 10-19 year olds was likely due to a few individuals with numerous clinic visits to address asthma-related problems. (ADHSS SOE, 2003).

COPD

Chronic obstructive pulmonary disease (COPD) is a disease that includes emphysema and chronic bronchitis. It is the most common form of chronic lower respiratory disease in adults. Cigarette smoking is the most common risk factor for COPD, but environmental and genetic factors can also contribute to the development of COPD.

In Alaska, COPD mortality rates have historically been higher among AN than Caucasians. COPD mortality rates have also increased among AN and have remained stable among whites in Alaska. The prevalence of self-reported COPD in the NSB was lower than the prevalence statewide from 2011-2013. For this time period, the prevalence of COPD in the NSB was 4.0% compared to 7.8% for AN statewide and 5.1% for all of Alaska (BRFSS, 2016).

HEC 8: Health Services Infrastructure and Capacity

The NSB and the Arctic Slope Native Association are jointly responsible for delivering health services to NSB residents (NSB, 2012). With the exception of Utqiaġvik, all NSB communities maintain a clinic that is staffed by medical personnel via the Community Health Aide Program (CHAP). These clinics do not have a physician or physician's assistant in residence. The Samuel Simmonds Memorial Hospital (SSMH) is located in Utqiaġvik and is a 14-bed hospital with an outpatient unit that consists of a 6-room clinic and a 2-bed emergency room (Arctic Slope Native Association, 2010). Utqiaġvik is the tertiary care center for the NSB villages; cases are referred to Fairbanks or Anchorage if they cannot be admitted by SSMH. Utqiaġvik also has a community mental health center, a dental clinic, and is the location of the NSB Department of Health and Social Services (NSB, 2012).

Access to services is limited by the remote location of the villages, cost of travel, and severity of the climate (NSB, 2010). Many of the communities in the NSB suffer from chronic health care workforce shortages and turnover (NSB, 2012). The U.S. Health Resources and Services Administration characterizes the NSB as a medically underserved and health professional shortage area (NSB, 2012). In 2016, there were only 0.4 licensed physicians per 1,000 population in the NSB, compared to 2.6 licensed physicians per 1,000 population statewide (ADPH, 2016).

Summary

Areas of Vulnerability

- Access to adequate health services can be limited by cost, difficulty of travel (i.e., weather, logistics), and the capacity of clinics.

Areas of Resilience/Success

- Comprehensive health services are available in Utqiaġvik for residents throughout the NSB service area.

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APPENDIX H

BOEM GREENHOUSE GAS LIFECYCLE MODEL METHODOLOGY

The following sections are the relevant excerpts from the Bureau of Ocean Energy Management's Outer Continental Shelf (OCS) Report 2016-065, Oil and Natural Gas: Potential Lifecycle Greenhouse Gas Emissions and Social Cost of Carbon (Wolvovsky, et al, 2016). The Bureau of Land Management used BOEM's Lifecycle Greenhouse Gas Emissions Model to predict the indirect emissions of greenhouse gases from the GMT2 Project. The modeling methodology and key assumptions are outlined below.

1. Greenhouse Gas Emissions Calculations Methodology

The following analysis includes emissions from the three largest GHGs: CO_2, CH_4, and N_2O. Fluorocarbons are used in very small quantities in refrigeration and in circuit breakers offshore, but are not deliberately released. This makes quantifying them very difficult, but their contribution relative to CO_2, CH_4, and N_2O emissions is very small; moreover, calculating fluorocarbon emissions would suggest the results have a greater degree of accuracy than is currently possible with available data. Additionally, the analysis has been spatially bounded to include emissions from U.S. consumption of OCS oil and gas, along with the substitution of sources for that energy under the No Action Alternative scenario where there is no 2017-2022 Program. The reasoning behind this is the insufficient data available for the kind and proportion of oil products used and a lack of information on overseas energy substitutions. The model estimates the emissions resulting from exploration, development, production, transportation to shore, onshore processing, delivery, and consumption of oil and gas products from the OCS, or their substitutes. This includes all OCS operations, as well as onshore refining, processing, storage, distribution, and consumption. It excludes emissions from secondary changes regarding OCS operations, such as BOEM's and oil and gas companies' office spaces, changes in vehicle fuel efficiency in response to changing market conditions, and others.

The following three subsections detail the approach for estimating GHG emissions. The first subsection addresses emissions released from offshore operations. The second subsection describes scaling emissions released as part of onshore processing and distribution, based on historic emission rates. Lastly, emissions resulting from consumption of petroleum and gas products are calculated using emissions factors and historic consumption patterns.

1.1 Emissions from OCS Exploration, Development, Production, and Transport

BOEM uses the Offshore Environmental Cost Model (OECM) to calculate the environmental and social costs and GHG emissions associated with oil and gas activity occurring on the OCS (BOEM 2015a, 2015b). OECM provides estimates for the monetized impact of typical activities associated with OCS production, including potential oil spills (other than catastrophic oil spills) occurring on the OCS. OECM uses economic inputs, resource estimates, and expected exploration and development scenarios with expected numbers of wells and associated production as the basis for its calculations. GHG emissions from OCS operations are estimated as follows, and a single total emissions number is reported for each of the three major GHGs:

Equation 1:

$$PE_{offshore} = \sum PE_{equipment}$$

$PE_{offshore}$ is the total emissions from offshore production in metric tons
$PE_{equipment}$ are the incremental emissions from using each piece of equipment such as drilling wells, constructing platforms, delivering supplies, and transporting resources to shore.

1.2 Emissions from Onshore Processing, Storage, and Distribution

Once onshore, oil is generally refined into petroleum products for specific uses, such as jet fuel, kerosene, and motor gasoline. A ratio of expected OCS production, to crude oil inputs, to refineries is used to scale emissions from refineries. Crude oil input data from 2014 (EIA 2016d) are used in coordination with 2014 GHG emissions from refineries (EPA 2016a). The same approach is used for natural gas storage and transmission; a ratio of OCS production and national gas consumption in 2014 (EIA 2016a) is used to scale the U.S. Environmental Protection Agency's (EPA) (2016a) inventory of natural gas systems emissions. It is assumed emissions from these activities are in proportion to the amount of oil and gas that make their way through these processes.

Equation 2.

$$PE_{onshore} = R_{oil}\frac{Oil_{OCS}}{Oil_{Total}} + SD_{ng}\frac{NG_{OCS}}{NG_{Total}}$$

$PE_{onshore}$ is total emissions from onshore processing in metric tons

R_{oil} is total emissions from all oil refining onshore in metric tons (EPA 2016a)

SD_{ng} is total emissions from storage and distribution of natural gas in metric tons (EPA 2016a)

Oil_{OCS} and Oil_{Total} are oil expected to be produced on the OCS, and total U.S. oil refinery inputs in 2014 (EIA 2016d), respectively in barrels (bbl)

NG_{OCS} and NG_{Total} are natural gas expected to be produced on the OCS, and total U.S. natural gas consumption from 2014 (EIA 2016a), respectively in millions of standard cubic feet (mmcf)

This equation is repeated for each of the GHGs being analyzed (CO_2, CH_4, and N_2O). R_{oil} and SD_{ng} are summed from EPA's (2016a) most recent inventory. R_{oil} includes emissions data from the following:

- Table 3-37 (Refining)
- Table 3-39 (Crude Refining)

SD_{ng} includes emissions data (EPA 2016a) from the following:

- Table 3-47 (Processing, Transmission and Storage, Distribution)
- Table 3-50 (Processing, Transmission and Storage, Distribution)

After being refined, oil is primarily transported using oil products as an energy source (EPA 2008). To avoid double counting, motor and other oils estimated in Section 4.3, are assumed to be consumed in proportion to the transportation of OCS oil. For more information on this assumption, see Section 7.

1.3 Emissions from Consumption

All oil and gas is assumed to be consumed in U.S. markets (for details on this assumption see Section 7). To determine the types of petroleum products Americans consume and in what proportion, EIA's (2016b) national 2015 consumption reports are used. A ratio is generated by dividing the national consumption of each petroleum product by overall oil consumption.

Equation 3.

$$C_i = \frac{Oil_i}{Oil_{Total}}$$

Where C_i is the consumption factor for end use of a petroleum product
Oil_i is the national consumption for a petroleum product in bbls
(EIA 2016b)
Oil_{Total} is total oil products consumed nationally in bbls (EIA 2016b)

This calculation is repeated for each petroleum product quantified by EIA and is used to generate Table 4-1 below.

Table 4-1. U.S. 2015 Oil Consumption

Petroleum Product	2015 Consumption (1000s of Gallons)	2015 Consumption (% of Total)
Asphalt and Road Oil	5,258,190	1.95
Aviation Gasoline	175,018	0.06
Distillate Fuel Oil	60,999,348	22.62
Jet Fuel (Kerosene Type)	23,574,985	8.74
Kerosene	110,097	0.04
Propane	17,223,255	6.39
Other Liquid Petroleum Gases	19,205,935	7.12
Lubricants	2,069,550	0.77
Motor Gasoline	140,380,643	52.06
Petroleum Coke	127,811	0.05
Residual Fuel Oil #6	94,444	0.04
Other Oil	452,022	0.17

Source: EIA 2016b
Note: Forty-two gallons is equal to 1 barrel of oil

When oil is refined, the volume of product increases as a result of the addition of other ingredients used to make each petroleum product. This volume increase is called the production gain. Currently, EIA estimates production gain to be 6.7 percent across all petroleum products (EIA 2015).

By allocating expected OCS production proportionately, based on the petroleum products and incorporating oil production gain, BOEM can apply EPA's recommended emissions factors for GHG

inventories (see Table 4-2). These categories of petroleum products do not match up perfectly between EIA and EPA. In two cases, distillate and residual fuel oils, there are multiple EPA emissions factors for a single EIA product category. In these instances, the amount of oil is evenly split among the possible emissions factors. This is a reasonable approximation since the fuel types are used enough in the U.S. for EPA to have researched and developed emissions factors for each. This does not have a major effect on the overall analysis since the emissions factors for the different distillate and residual fuel oil categories are very similar.

Table 4-2. Petroleum Emissions Factors for Greenhouse Gas Inventories in kg/gallons

Petroleum Product	CO_2	CH_4	N_2O
Asphalt and Road Oil	11.91	0.00047	0.00009
Aviation Gasoline	8.31	0.00036	0.00007
Distillate Fuel Oil #1	10.18	0.00042	0.00008
Distillate Fuel Oil #2	10.21	0.00041	0.00008
Distillate Fuel Oil #4	10.96	0.00044	0.00009
Jet Fuel (Kerosene Type)	9.75	0.00041	0.00008
Kerosene	10.15	0.00041	0.00008
Propane	5.72	0.00027	0.00005
Other Liquid Petroleum Gases	5.86	0.00028	0.00006
Lubricants	10.69	0.00043	0.00009
Motor Gasoline	8.78	0.00038	0.00008
Petroleum Coke	14.64	0.00043	0.00009
Residual Fuel Oil #5	10.21	0.00042	0.00008
Residual Fuel Oil #6	11.27	0.00045	0.00009
Other Oil (> 401°F)	10.59	0.00042	0.00008

Source: EPA 2015

Some oil and natural gas are used as an ingredient for non-combustible products such as fertilizer and petrochemicals; this portion is removed from the consumption calculations since these products are not combusted and their use does not result in GHG emissions. EIA reports that 1.6 percent of all natural gas and 1.2 percent of all oil is never combusted (EIA 2012). Thus, the estimation for emissions from consumption of OCS oil is a summation of the emissions from each distinct petroleum product, as shown in Equation 4 below:

Equation 4.

$$CE_{oil} = PG * CP_{oil}(1 - NC_{oil}) * \sum_{i=1}^{i=n} [C_i * EF_i] * 1{,}000$$

CE_{oil} is total emissions from oil consumption in metric tons
PG is the percent processing gain
CP_{oil} is OCS oil produced in gallons
NC_{oil} is the proportion of oil which is not combusted
C_i is the consumption factor for end use of a petroleum product (ratio, see Equation 3)
EF_i is the emission factor for each petroleum product in kilograms (kg) per gallon.
$_i$ refers to each of the petroleum products listed in Table 4-2.
1,000 converts kg to metric tons

Since natural gas is not refined into other combustible products, there is no processing gain; moreover, there is only a single product to assess even though natural gas is used in different markets. EPA (2015) provides a single set of emissions factors for natural gas (see Table 4-3), making the estimation straight forward, as follows:

Equation 5.

$$CE_{ng} = CP_{ng}(1 - NC_{ng}) * EF_i * 1{,}000$$

CE_{ng} is total emissions from natural gas consumption in metric tons,
CP_{ng} is natural gas produced and consumed in mmcf,
NC_{ng} is the proportion of natural gas that is not combusted in mmcf, and
EF_i is the emission factor for natural gas in kg per mmcf
1,000 converts kg to metric tons

Table 1-3. Natural Gas Emissions Factors for Greenhouse Gas Inventories in kg/scf

Petroleum Product	CO_2	CH_4	N_2O
Natural Gas	0.05444	0.00103	0.00010

Source: EPA 2015

Finally, total emissions, in metric tons, can be summed as E_{total}:

Equation 6.

$$E_{total} = PE_{offshore} + PE_{onshore} + CE_{oil} + CE_{ng}$$

1.4 Emissions from Energy Substitutes

To evaluate the difference between new OCS oil and gas leasing during the 2017–2022 Program and a No Action Alternative (i.e., no new leases in the 2017–2022 Program), BOEM uses information from EIA to estimate energy sources that would be used in absence of the 2017–2022 Program to meet energy demand. The determination of energy substitutes adopts EIA's assumptions that account for current laws, not potential future policies that could reduce emissions. BOEM estimates the GHG emissions that would otherwise be emitted from the other sources of energy Americans could use in place of OCS oil and gas from new leasing. Energy substitution includes meeting energy needs from other sources of oil and natural gas such as production from state submerged lands, onshore domestic production, and international imports. Coal, biofuels, and nuclear and renewable energy sources are substituted for OCS oil and gas in lesser amounts. In addition, it is assumed that there would be some conservation measures, including reduced demand and consumption of all energy sources due to higher oil and gas prices in the absence of new OCS resource availability. To determine the amount of GHG emissions for substituted energy sources, BOEM estimates the lifecycle emissions of the oil, gas, and other sources of energy used to replace OCS oil and gas.

Changes in energy consumption patterns are estimated using BOEM's energy market simulation model, MarketSim (Industrial Economics, Inc. 2015). MarketSim is the same model used to evaluate substitutions in the 2017–2022 Program economic analysis. This model simulates end-use domestic consumption of oil, natural gas, coal, and electricity in four sectors (residential, commercial, industrial, and transportation); primary energy production; and the transformation of primary energy into electricity. MarketSim mostly represents U.S. energy markets, but also captures interaction with world energy markets as appropriate. The model takes current measures of energy production, consumption, and prices assuming no new OCS leasing as a baseline to which a given scenario of OCS production is added. Accounting for substitution between different sources of energy, the model calculates equilibrating prices for oil, natural gas, coal, and electricity based upon the expected increase in OCS production of oil and gas.

For purposes of these GHG calculations, BOEM assumes nuclear, biofuels, solar, and wind sources have negligible GHG emissions at final consumption either because the emissions are small by unit, or because the amount of substituted emissions are less than one percent (BOEM 2015a, 2015b, and 2016). These negligible emissions are not analyzed in this report with one exception. Although coal is expected to substitute for a very small portion of OCS oil and gas (less than one percent in the 2017–2022 Program), its higher rate of GHG emissions per unit of energy makes it worth evaluating. Coal is expected to substitute for natural gas in electrical power generation. BOEM uses EPA's (2015) emissions factors (see Table 4-4) combined with the substitution rate estimated by MarketSim to calculate emissions from coal (see Equation 7).

Table 4-4. Coal Emissions Factors for Greenhouse Gas Inventories in kilograms/million British Thermal Units

Emissions Source	CO_2	CH_4	N_2O
Mixed (Electric Power Sector)	95.52	11	1.6

Source: EPA 2015

Equation 7.

$$C_{cons} = O_{coal} * EF_{coal} * 1000$$

C_{cons} is the emissions from the consumption of substituted coal in metric tons
O_{coal} is the amount of coal replacing OCS products in British thermal units
EF_{coal} is the emissions factor for Mixed Coal (Electric Power Sector) in metric tons per British thermal unit (EPA 2015)
1000 converts kg to metric tons

The overall emissions as a result of substitution are totaled using emissions from exploration, development, production (including tankering), processing, storage and distribution, and consumption of the substituted resources. OECM, the model used to calculate offshore emissions (see Section 4.1), provides similar emissions values for non-OCS production. This includes emissions from oil, gas, coal, and other substituted sources of energy. If the energy, such as oil, is substituted by foreign sources, the GHG emissions released from bringing these products to the U.S. are included.

The summation of production and consumption of substituted sources is reflected in the following equation:

Equation 8.

$$E_{nd} = O_{prod} + CE_{oil} * S_{oil} + CE_{ng} * S_{ng} + C_{cons}$$

E_{nd} is the total emissions from oil and gas consumption when there is no new drilling on the OCS in metric tons
O_{prod} is the total emissions of all substituting sources in metric tons as estimated in OECM
CE_{oil} and CE_{ng} are total emissions from oil (see Equation 4) and natural gas (see Equation 5); consumption is in metric tons
S_{oil} and S_{ng} are the oil and gas substitution rates, estimated by MarketSim
C_{cons} is the emissions from the consumption of substituted coal in metric tons (see Equation 8)

O_{prod} in Equation 8 originates from OECM, which assumes oil production overseas is more GHG-intensive than production on the OCS. For example, CO_2 emissions occurring on the OCS are approximately 0.007759 metric tons per barrel of oil equivalent (boe) versus overseas production, which OECM estimates at 0.036522 metric tons per boe. This relationship between OCS and foreign oil production has been corroborated by other studies (Gordon 2015). To a lesser degree, these higher emissions can also be attributed to OECM assuming two-way trips of tankers bringing oil to the U.S.

To support calculating the SC-CO_2, and to provide a direct comparison between the three different pollutants calculated, BOEM uses Global Warming Potential, also known as CO_2e. The purpose behind converting into a CO_2e is to provide a direct comparison between emissions with different potential to trap heat and different atmospheric lifespans. For example, one metric ton of CH_4 has a similar impact as 25 metric tons of CO_2e. EPA's (2015) conversion factors are used (see Table 4-5).

Table 4-5. Global Warming Potential in Metric Tons

Greenhouse Gas	Global Warming Potential (CO_2e)
CO_2	1
CH_4	25
N_2O	298

Source: EPA 2015

2. Key Assumptions

This analytical model makes a number of assumptions, which could reduce its accuracy; the assumptions are characterized here. The principal variable in this estimation is the production estimates of OCS oil and gas; the underlying uncertainty in the estimates of the amount of oil and gas to be produced has a profound impact on overall accuracy. These production estimates are a critical input into MarketSim and OECM, models which in turn necessarily rely on a series of assumptions. Other critical assumptions that affect the GHG emissions estimates are as follows:

1. **Near constant demand is assumed over the next 40–70 years for oil and gas.**

This analysis uses a projection of near constant demand over the next 40–70 years using the 2016 AEO Reference Case, for which EIA does not assume any future changes in laws or policies other than what is incorporated in existing laws and policies. As countries, including the U.S., address climate change with individual policy targets, this assumption could no longer hold. Additionally, as new energy sources become more economically feasible, they could displace existing sources and/or alter the composition of energy supply. The Reference Case is the best baseline currently available. This analysis could be adapted in the future to incorporate policy shifts that affect demand for oil and gas.

2. **Engines used for production, processing, and consumption of oil and gas will not become more efficient, and oil and gas will remain a primary energy source.**

Historically, engines have become increasingly efficient both in the offshore and onshore environments, but those engines by and large have remained dependent on fossil fuels. Moreover, the *President's Climate Action Plan* (White House 2013) calls for energy and transport efficiency improvements, including transitioning from more intense GHG energy sources. One of the key tenets of the *President's Climate Action Plan* is the reduction of methane from oil and gas production facilities. Efficiency improves through the need for greater economy, and also through Government regulation. These changes could alter the fuel type or quantity of oil and gas used to generate power. Similar changes will impact other types of oil and gas products, such as lubricants and plastics. These changes will alter more than just the amount of oil, but the portion of each barrel being consumed by any sector. For instance, in 2015, motor gasoline represented 52 percent of all oil products by volume. As battery technologies continue to improve, plug-in electric vehicle prices could continue to drop (Nyvist and Nilsson 2015), and the percent of oil used for motor gasoline could drop as the share of electric vehicles increases. However, as the American electrical grid is increasingly dependent on natural gas, such shifts could increase demand for those resources.

Figure 3 shows how consumption patterns of oil have changed in the past, including the rise of jet fuel and motor gasoline use, and the contraction of residual fuel oil use. Despite these longer-term shifts, petroleum products maintain a reasonable level of continuity from year to year. For example, motor gasoline, the largest consumed petroleum product, has never exceeded 52 percent (2015) of total consumption, nor has it dropped below 39 percent (1980) since 1950. During that entire time, it remained the largest petroleum product consumed by Americans.

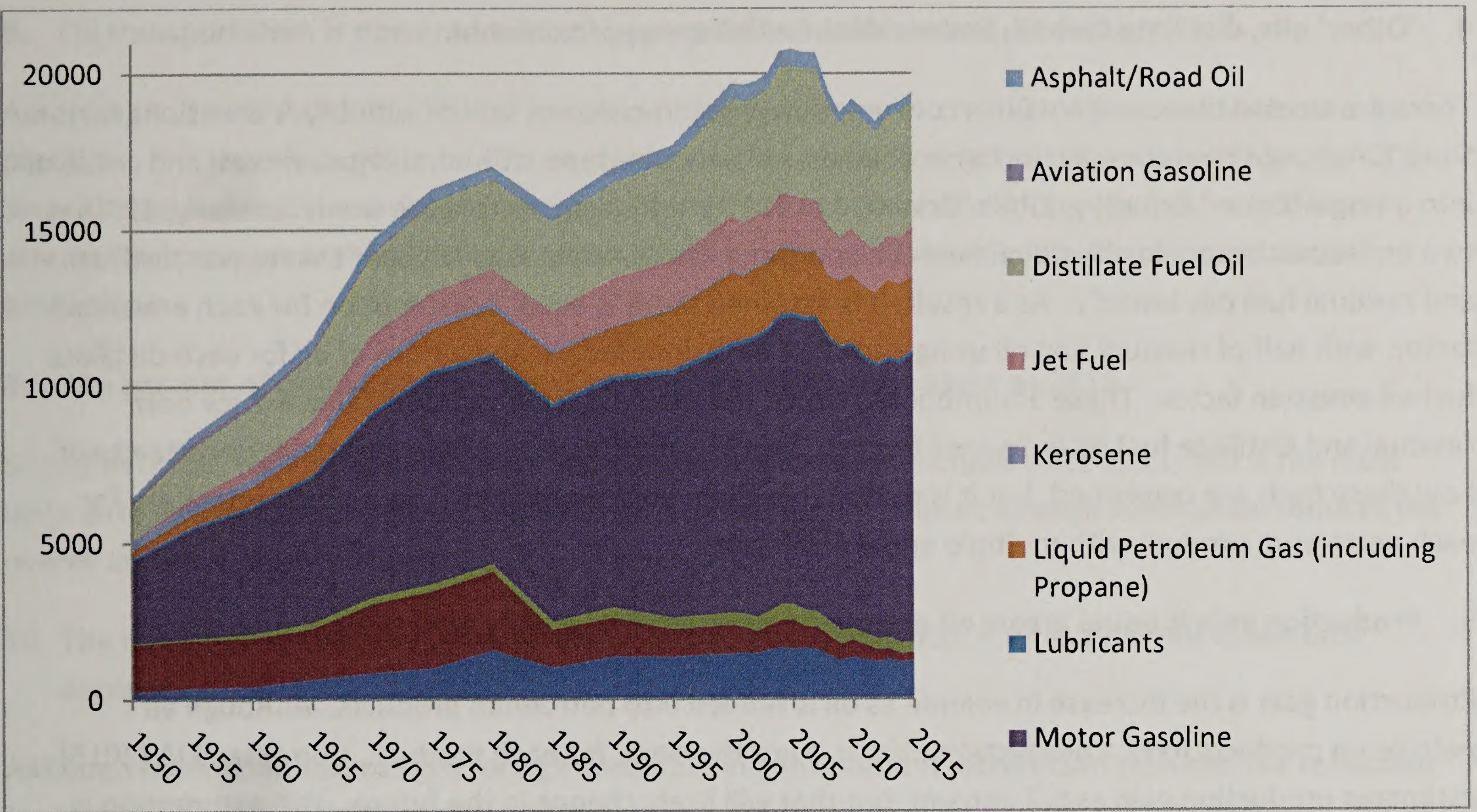

Figure 1. Historical U.S. Average Consumption per day of Petroleum Products by Year (1950 – 2015) in Thousands of Barrels (EIA 2016b)

Without a definitive method of estimating oil consumption and petroleum markets for the coming 70 years, it is impossible to predict how oil and gas consumption will change. Using 2015 data still provides a useful approximation of consumption because the consumption patterns have not radically changed over the short-term. Longer-term trends could be incorporated by keeping the model up to date with consumption patterns. It is likely that efficiency will continue to improve, meaning less oil and gas will be required to generate the same amount of energy. This also affects upstream calculations, including the offshore exploration, development, and production, and onshore processing, storage, and distribution. This impacts both the evaluation of OCS activities, as well as energy substitutions, thereby still allowing a user to directly compare emissions.

These assumptions are necessary because it is uncertain how oil consumption will change in the future. However, this assumption is reasonable because of the historical stability in proportionality of petroleum product consumption.

3. All oil and gas on OCS leases is produced, processed, and consumed.

This analysis assumes all the oil and gas expected to be discovered on the OCS is produced, processed, and consumed. In reality, some oil and gas is lost, either by not being brought to production, or through inefficiencies at various stages of processing and distribution or other incidents, such as spills. These results assume that all oil removed from the OCS makes its way through to a customer and is consumed with perfect efficiency. This assumption is currently the only way to conduct this analysis currently; however, it ensures emissions will not be underestimated. Petroleum products that are not combusted are accounted for in this analysis.

4. 'Other' oils, distillate fuel oil, and residual fuel oil are approximated.

There are several places where EIA's consumption categories do not match with EPA's emissions factors. Since EIA groups pentanes, petrochemical feedstocks, naptha-type jet fuel, still gas, waxes, and crude oil into a single 'Other' category, EPA's 'Other Oil (> 401°F)' emissions factors are used. Similarly, EPA has two emissions factors for 'Residual Fuel Oil' and three for 'Distillate Fuel Oil,' but EIA reports distillate and residual fuel oils broadly. As a result, it is assumed there is equal consumption for each emissions factor, with half of residual fuel oil using each EPA emissions factor, and a third of oil for each distillate fuel oil emission factor. These assumptions reduce the model's accuracy. See Table 4-2 for both residual and distillate fuel oil emissions factors. This assumption is necessary given the uncertainty of how these fuels are consumed, but it is reasonable given how similar EPA's emissions factors are for each petroleum product with multiple emissions factors.

5. Production gain is equal across all petroleum products and steady over time.

Production gain is the increase in volume as oil is refined into petroleum products. Although all petroleum products have a production gain, it is not the same for each product. Currently, EIA (2015) estimates production gain as 6.7 percent, but that will likely change in the future. This assumption is necessary given the lack of available information regarding the production gain of individual fuels.

6. All oil and gas is consumed domestically.

Emissions from the export of U.S.-produced oil and gas are relatively minor compared to the amount produced, processed, and consumed domestically. This assumption slightly underestimates the emissions from transportation of these products to other countries. Since emissions factors for natural gas do not vary, if they are consumed overseas, their emissions factors remain the same. However, since oil is consumed in a variety of products, which have a wide range of emissions factors, there is some loss in accuracy for petroleum products consumed overseas, since other counties do not consume these products in identical proportions to the U.S. Even with the loss of accuracy, approximating global emissions from oil using the United States as the example provides a reasonable example of oil consumption. These assumptions are reasonable given the small amount of oil and gas products exported (EIA 2016e).

7. OCS oil is refined into the same petroleum products and consumed in the same proportions as oil and gas nationally.

It is likely OCS oil is refined into specific petroleum products, and those products are not in the same proportions as oil from all sources. However neither BOEM nor EIA have information specifically identifying what petroleum products OCS oil is refined into, and in what proportions. Should more specific information about the type of products OCS oil is refined into become available; the analytical model would be adjusted to accommodate such information. This assumption is necessary given the current lack of information.

8. Oil transportation is powered with oil in proportion to the overall production.

According to the EPA (2008), the vast majority of transporting oil to market is powered with petroleum products. It is therefore assumed this oil is consumed in proportion to the oil produced from the OCS. Since this oil is already accounted for as part of the consumption calculations, there is no additional attempt to incorporate these emissions separately, which would result in double counting these emissions.

9. The percent of oil and gas that remains un-combusted is the same as 2011.

Since EIA (2012) has not updated their non-combusted use of fossil fuels since 2011, this is the most up to date information available. Similar to other assumptions, this no-change assumption reduces the overall accuracy of the analysis.

10. The reduction in foreign consumption of oil and gas in a no action analysis is not taken into account.

Although MarketSim estimates a foreign reduction in consumption, MarketSim provides the reduction for oil only. MarketSim does not model natural gas fluctuations in the global market. However, for the global oil market, MarketSim substitutions under the No Action Alternative show a reduction in foreign oil consumption of approximately 1, 4, and 6 billion barrels of oil for the low-, mid-, and high-price scenarios, respectively, over the duration of the 2017–2022 Program. GHG impacts for this reduction in oil consumption, as well as possible changes for natural gas, are not captured in this analysis.

The implications for oil and gas production in other countries relating to U.S. decisions about issuing leases are highly uncertain. In the substitution analysis based on MarketSim, the assumption is made that other oil producing countries will supply oil for U.S. import without additional restraints due to GHG-related policies in those countries. This might change in the future if other countries establish policies to achieve their GHG-related targets.

Excluding the foreign oil and gas markets is reasonable. Oil consumption in each country is different, and BOEM does not have information related to which countries would consume less oil. This is important information since consumption patterns vary by country. For gas consumption, BOEM does not have information related to how changes in the U.S. market would affect other countries.

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APPENDIX I

REQUEST FOR DEVIATIONS FROM LEASE STIPULATIONS AND BEST MANAGEMENT PRACTICES

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October 30, 2017

Ms. Stephanie Rice
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Re: Request for Deviations from Lease Stipulations and Best Management Practices GMT2 Development

Dear Ms. Rice:

ConocoPhillips Alaska, Inc. (CPAI), as Operator on behalf of the working interest owners of the Greater Mooses Tooth (GMT) Unit, seeks Bureau of Land Management (BLM) approval for two deviations from lease stipulations and Best Management Practices (BMPs) for the GMT2 project. Two of the deviations requested here were also requested and approved in 2015 for GMT1 project. The deviations would allow the GMT2 access road to be the shortest length, on the driest land with the lowest habitat value.

Background on BMPs and Lease Stipulations

The scheme for lease stipulations and BMPs has become complicated as National Petroleum Reserve – Alaska (NPR-A) Integrated Activity Plans (IAP) have been revised over the years. Oil and gas leases in the GMT2 project are were issued in 1999, subject to stipulations identified in the detailed statement of sale for NPR-A Oil and Gas Lease Sale 991, which are also reflected in the Record of Decision (ROD) for the 1998 NPR-A Integrated Activity Plan (1998 ROD). The 1998 ROD clearly anticipated and provided for exceptions to lease stipulations upon a finding that implementation of a stipulation is (1) technically not feasible, economically prohibitive, or that an environmentally preferable alternative is available, and (2) the alternative means proposed fully satisfies the objective of the stipulations. See Appendix B to 1998 ROD. Thus, the lease stipulations were not intended to be inflexible, and were not intended to preclude or unduly impede reasonable oil and gas development proposals.

The suite of lease stipulations and BMPs (previously called Required Operating Procedures, or ROPs) were modified and supplemented in the ROD for the 2008 Integrated Activity Plan (2008 ROD). The 2008 ROD did not purport to apply the modified lease stipulations to pre-existing leases, but in connection with lease extension applications, CPAI notified BLM, in a letter dated April 6, 2009, that it "will apply the IAP/EIS lease stipulations and Required Operating Procedures under the 2008 Record of Decision." The 2008 stipulations and BMPs were essentially reiterated in the 2013 ROD for the most recent NPR-A IAP (2013 ROD).

In short, most Greater Mooses Tooth Unit leases are subject to the lease stipulations set forth in the 2008 ROD, and subject to BMPs set forth in the 2013 ROD. Both documents clearly allow for deviations. As stated on page 43 of the 2013 ROD: "A lessee/permittee may propose a deviation from the requirements/standards of stipulations and best management practices as part of an authorization application." The two provisions from which CPAI is seeking approved deviations are set forth in Attachment 1.

Deviation Request for Lease Stipulation E-2 (Facilities Within 500 Feet of Water Bodies)

CPAI first seeks a deviation from Lease Stipulation E-2 (2008), which prohibits permanent oil and gas facilities, including roads and pipelines, within 500 feet of fish bearing water bodies and aquatic habitats. A map illustrating all rivers, streams, and lakes within 500 feet of the Alternative A facilities is included as Attachment 2 for reference. As shown on that map, the road route for Alternative A comes within 500 of one named lake (M9925).

The objective of Lease Stipulation E-2 is to protect fish-bearing waterbodies, water quality, and aquatic habitats. In the 2013 IAP, Stipulation E-2 was clarified to apply only to fish-bearing waterbodies. The terms of Lease Stipulation E-2 in both the 2008 and 2013 versions expressly provide: "Essential pipeline and road crossings will be permitted on a case-by-case basis."

The GMT2 project area, like much of the North Slope, contains abundant lakes, rivers, streams, creeks, and ponds. These water bodies are prevalent because the area is underlain by permafrost, which generally prohibits drainage. Additionally, this area is classified as wetlands, attesting to presence of numerous water bodies. The 2004 Alpine Satellite Development Plan EIS (Sections 3.2.1.1 and 3.2.2.1) states:

- "The tundra covered Arctic Coastal Plain ... is generally characterized by periglacial features associated with flat topography, poor drainage, and underlying permafrost. Thaw-lakes and polygonal surface patterns on inter-lake ice wedges are the dominant terrain features."
- "Abundant thaw-lakes and marshy thaw-lake basins, generally only a few feet deep, cover 25 to 30 percent of the landscape."
- "Lakes and ponds are the most prevalent features of the Plan Area."

Because of the abundance of water bodies in the area, it is not technically possible, let alone technically feasible, to locate all facilities farther than 500 feet from the highest high-water mark of all active floodplains. CPAI selected the proposed locations for pads, roads, and pipelines by balancing engineering, habitat, economics, hydrology, and other environmental factors, such as avoiding bird nest locations, to the extent possible. Maintaining a distance of 500 feet from every water body, while also minimizing gravel footprint, is not practicable in this environment.

Even where facilities need to be placed closer than 500 feet from a water body, the objective of Lease Stipulation E-2, protection of water quality, would still be satisfied. Standard practices such as pipeline inspections and other spill prevention efforts will protect water bodies from potential spills to the extent possible. Secondary containment for tanks, tank inspection procedures, and refueling practices minimize the chance of a potential tank spill leaving a pad and entering a water body. Spill response equipment will be staged near sensitive areas and agency approved spill plans will be in place.

BLM granted approval an exception from this requirement in 2004, based on technical infeasibility of total compliance due to the hydrology and number of water bodies in the area as well as implementation of other measures that would protect water bodies (*e.g.*, use of secondary containment). [1] BLM reaffirmed this decision, speaking terms of a "deviation" rather than an exception, for the GMT1 development at page 7 of the GMT1 ROD, issued in 2015. CPAI now requests confirmation that the 2004 exception remains in effect to allow the location of facilities closer than 500 feet from water bodies where necessary based on other environmental and engineering factors.

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[1] In the 2004 Alpine Satellite Development Plan ROD, this Lease Stipulation is referred to on page 3 as "Stipulation 41."

Deviation Request for BMP E-7c (500 Feet Between Pipelines and Roads)

CPAI's second request is for a deviation from BMP E-7c., which requires a minimum distance of 500 feet between pipelines and roads. A map illustrating the locations where the pipeline route would put the within 500 feet of the proposed gravel road is included as Attachment 3 for reference. Four stretches of the Alternative A road and pipeline routes locate the pipeline within 500 feet of the gravel road. These are 3,990 feet of road and pipeline near lake M9925, 3,909 feet near lake M9923, 4,803 feet near lake Z06005, and 1,195 feet near lake R0062. These particular distances and locations may change subject to potential pipeline route modifications.

The objective of BMP E-7c is to minimize disruption of caribou movement and subsistence use. The standard is for pipelines and roads to be designed to allow the free movement of caribou and the safe, unimpeded passage of the public while participating in subsistence activities. The BMP also states: "Separating roads from pipelines may not be feasible within narrow land corridors between lakes and where pipelines and roads converge on a drill pad. Where it is not feasible to separate pipelines and roads, alternative pipeline routes, designs and possible burial within the road will be considered by the authorizing officer."

Separating the pipeline from the gravel road by more than 500 feet, while also staying 500 feet away from nearby lakes, is not feasible at locations 1-4 marked in Attachment 3. Location 2 is also narrowed by the need to keep the road out of the Fish Creek setback. The nearest the road comes to the pipeline at location 1 is approximately 359 feet, at location 2, 337 feet, at location 3, 269 feet, and at location 4, 458 feet.

Even where pipelines and roads would be placed closer than 500 feet, the objective of BMP E-7c, that the pipelines and roads would be designed to allow the free movement of caribou and the safe, unimpeded passage of the public while participating in subsistence activities, will still be satisfied. The pipeline height will be a minimum of 7 feet allowing unimpeded passage, and road pullouts have been proposed to support subsistence activities and provide a safe place for subsistence hunters to rendezvous while hunting or traveling to camp and cabin sites.

For the reasons set forth above, CPAI requests a deviation from ROP E-7c as necessary to allow certain stretches of road and pipeline to be less than 500 feet apart.

Conclusion

CPAI's proposed project design minimizes environmental impact, but requires minor deviations from just two of the approximately 70 lease stipulations and BMPs that apply to the project. Please call me if you have any questions or need additional information about this request.

Respectfully,

Robyn McGhee

Robyn McGhee for
Brad Thomas

cc:

Stacie McIntosh, BLM
Stephen Moore, USACE
Louise Smith, USFWS
Jennifer Curtis, USEPA

References:

U.S. Department of Interior, Bureau of Land management (BLM). 2015. Supplemental Environmental Impact Statement (EIS) for the Alpine Satellite Development Plan for the Proposed Greater Mooses Tooth One Development Project Record of Decision (ROD). U.S. Department of the Interior, Bureau of Land management, Anchorage, Alaska. U.S. Department of the Interior, Bureau of Land management, Anchorage, Alaska.

.2013. National Petroleum Reserve-Alaska (NPR-A). Final Integrated Activity Plan (IAP)/Environmental Impact Statement (EIS) Record of Decision (ROD).

.2008. Northeast National Petroleum Reserve Alaska Integrated Activity Plan(IAP)/Environmental Impact Statement (EIS) Record of Decision (ROD). BLM/AK/PL-05/002+3130+931.

.2004. Alpine Satellite Development Plan Record of Decision (ROD). BLM/AK/PL-05/002+3130+931

.1998. Northeast National Petroleum Reserve Alaska Integrated Activity Plan/Environmental Impact Statement Record of Decision. U.S. DOI, Bureau of Land Management.

Attachment 1

Lease Stipulation and Best Management Practices Requiring Exception for GMT1 Alternative A

E-2 Lease Stipulation (2008)

Objective: Protect fish-bearing water bodies, water quality, and aquatic habitats.

Requirement/Standard: Permanent oil and gas facilities, including roads, airstrips, and pipelines, are prohibited upon or within 500 feet as measured from the ordinary high-water mark of fish-bearing waterbodies. Essential pipeline and road crossings will be permitted on a case-by-case basis.

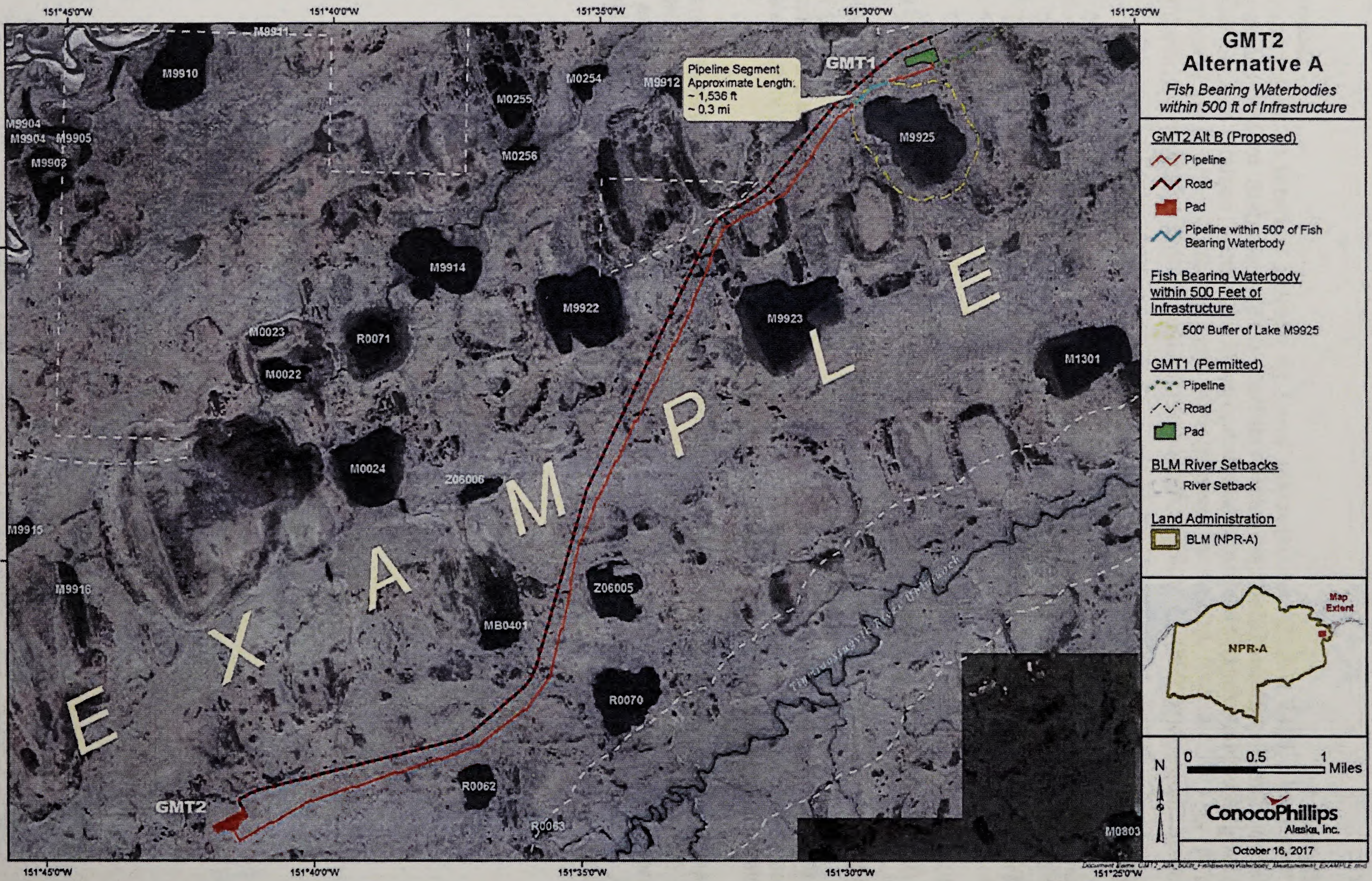
E-7c Best Management Practice

Objective: Minimize disruption of caribou movement and subsistence use.

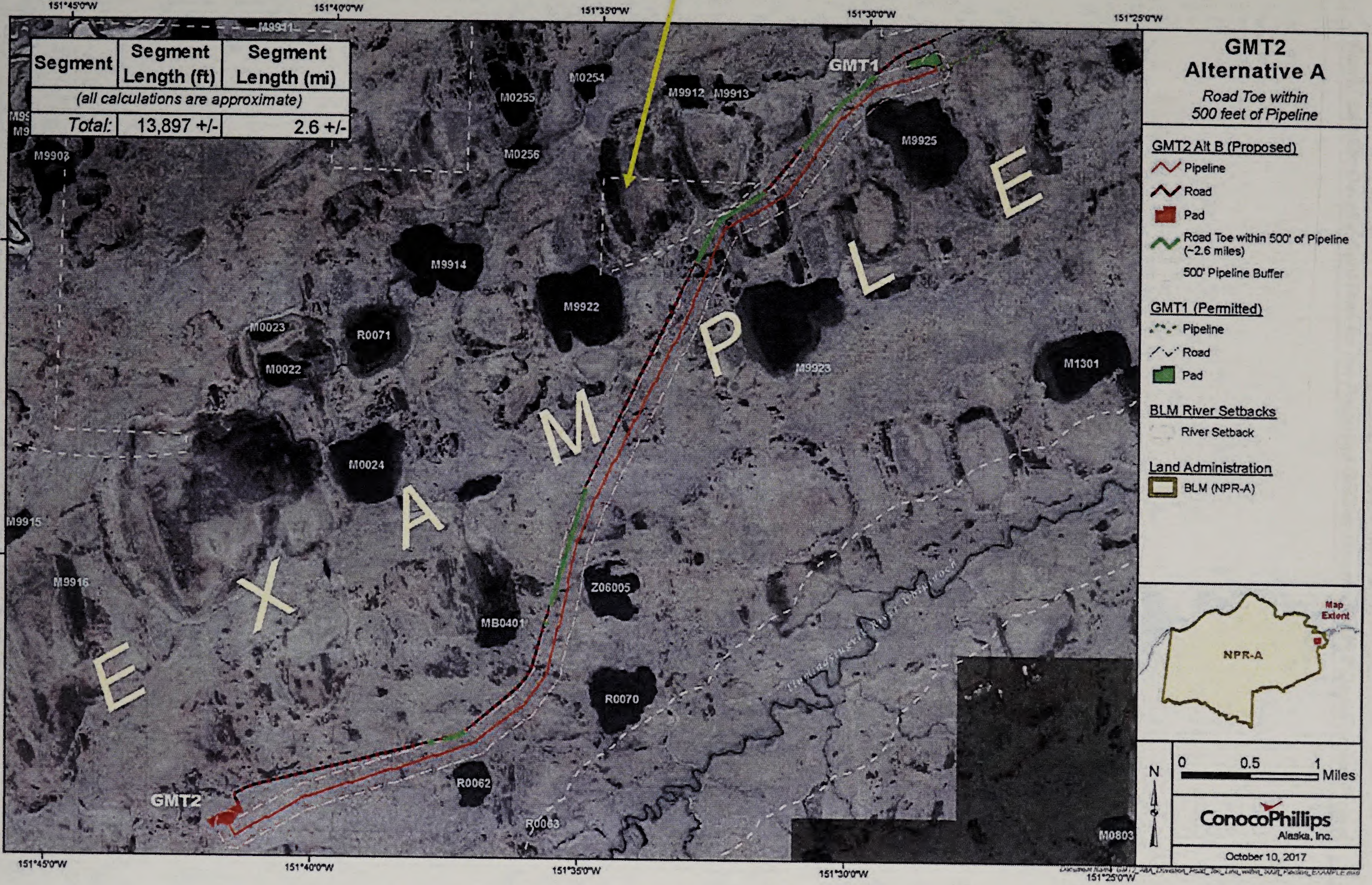
Requirement/Standard: Pipelines and roads shall be designed to allow the free movement of caribou and the safe, unimpeded passage of the public while participating in subsistence activities. Listed below are the accepted design practices:

c. A minimum distance of 500 feet between pipelines and roads shall be maintained. Separating roads from pipelines may not be feasible within narrow land corridors between lakes and where pipelines and roads converge on a drill pad. Where it is not feasible to separate pipelines and roads, alternative pipeline routes, designs and possible burial within the road will be considered by the authorized officer.

Attachment 2: Fish Bearing Water Bodies within 500 Feet of Infrastructure



Attachment 3: Road Toe within 500 Feet of Pipeline



Attachment 8: Fish Bearing Water Bodies within 500 Feet of [illegible]

APPENDIX J

NPR-A INTEGRATED ACTIVITY PLAN BEST MANAGEMENT PRACTICES AND STATE OF ALASKA REGULATIONS PROTECTING ENVIRONMENTAL QUALITY

APPENDIX A: LEASE STIPULATIONS AND BEST MANAGEMENT PRACTICES

Definitions

The following definitions apply to the stipulations and best management practices listed in this appendix. The Glossary of the Final IAP/EIS has additional definitions.

Active Floodplain: The lowland and relatively flat areas adjoining inland and coastal waters, including the flood-prone areas of offshore islands, composing, at a minimum, that area subject to a 1 percent or greater chance of flooding in any given year (also referred to as the 100-year or base floodplain).

Authorized Officer: A position of authority for approval of various activities through delegation from the Secretary of the Interior. Currently, the designated authorized officers in Alaska for leasing, surface use, and permitting are 1) State Director, 2) Manager of the Arctic Field Office in Fairbanks, and 3) Deputy State Director, Division of Resources.

Best Management Practice: Mitigation developed through the BLM planning process/NEPA process that is not attached to the oil and gas lease but is required, implemented, and enforced at the operational level for all authorized (not just oil and gas) activities in the planning area.

Best management practices were developed with various mechanisms in place to ensure compliance. These mechanisms include the following:

1. Some best management practices are pre-application requirements; therefore compliance will <u>precede</u> approval of the proposed activity. For example, Best Management Practice H-1(a) requires consultation with affected communities <u>prior</u> to submission of an application for relevant activities within the NPR-A. If consultation has not taken place, the application will be rejected or will be considered incomplete until such time that the consultation has occurred.
2. Other best management practices are required design features, and will have to be incorporated into the applicant's proposal. As an integral part of the proposal and the authorization, the requirement

does not need to be stipulated to be enforceable. For example, a minimum pipeline height of 7 feet for above ground pipelines is a required design of any approved above ground pipeline (Best Management Practice E-7). Since the authorization (a ROW in this case) authorizes a pipeline with a minimum height of 7 feet, anything less (unless specifically approved through additional NEPA analysis and the permit) is not in compliance and enforcement actions may be taken even if the permit does not specify a minimum of 7 feet.

3. Other best management practices will become conditions of approval on post lease land use authorizations. For example, Best Management Practice C-1 prohibits heavy equipment used for cross-country moves within ½ mile of occupied grizzly bear dens.

Body of Water or Water body: A lake, river, stream, creek, or pond that holds water throughout the summer and supports a minimum of aquatic life.

Buffer: A zone extending outward or inward from the periphery of a "protected" feature for a specified distance. Activities and development may be prohibited or limited by type or time within the buffer dependent on the goal associated with applying the buffer.

Class I air quality area: One of 156 protected areas such as national parks (over 6,000 acres), wilderness areas (over 5,000 acres), national memorial parks (over 5,000 acres), and international parks that were in existence as of August 1977, where air quality should be given special protection. Federal Class I areas are subject to maximum limits on air quality degradation called air quality increments (often referred to as Prevention of Significant Deterioration [PSD] increments). All areas of the United States not designated as Class I are Class II areas. The air quality standards in Class I areas are more stringent than national ambient air quality standards.

Consultation: Consultation, as it is referenced in the lease stipulations, does not infer formal consultation as required under other legal mandates such as "Section 7 Consultation" under the ESA. Rather, consultation implies that the BLM or the Lessee/Permittee will contact other agencies or entities to inform them of potential actions and to seek input on noted topics. This includes informal contacts, and written, electronic, and/or verbal communication.

Criteria Air Pollutants: Those pollutants subject to the National Air Quality Standards (http://www.epa.gov/air/criteria.html). They currently include carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), ozone (O_3), particulate matter (both PM_{10} and $PM_{2.5}$ – inhalable and respirable particulates), and sulfur dioxide (SO_2).

Development Activities: Any activity associated with construction and operation of facilities or equipment post exploration.

Field: The term used to describe the area containing surface infrastructure above one or more subsurface reservoirs. In this sense, "field" is analogous to "a Unit participating area or collection of participating areas." The infrastructure in the field includes, but is not limited to, drilling and production pads, service roads, perhaps an airstrip, and processing and support facilities. Field infrastructure may be used in the development and production of several oil/gas accumulations in different subsurface reservoirs. Fields typically have a primary reservoir that supports initial development in addition to satellite reservoirs that are developed later and tie into the main facilities. Although oil and gas reservoirs may vary greatly in subsurface depth and other geologic characteristics, because they are located in the same geographic area it is more efficient to coordinate and share the necessary surface infrastructure. Fields may or may not be connected by permanent roads to adjacent fields or transportation facilities outside the field area.

Greenhouse gas (GHG): A gas that absorbs and emits thermal radiation within the lowest layers of the atmosphere. This process is the fundamental cause of the greenhouse effect. The primary greenhouse gases that are considered air pollutants are carbon dioxide, (CO_2), methane (CH_4), nitrous oxide (N_2O), and chlorofluorocarbons (CFCs).

Hazardous air pollutants (HAPs): (also known as toxic air pollutants) Those pollutants that cause or may cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental and ecological effects. The Environmental Protection Agency (EPA) is required to control 187 hazardous air pollutants. Examples of HAPs include benzene (found in gasoline), perchlorethlyene (emitted from dry cleaning facilities), and methylene chloride (used as a solvent).

Lease Stipulation: Mitigation developed through BLM planning process/NEPA process that is specifically attached to a lease.

NO_x: Mono-nitrogen oxides, including nitric oxide (NO) and nitrogen dioxide (NO_2). It is formed when naturally occurring atmospheric nitrogen and oxygen are combusted with fuels in automobiles, power plants, industrial processes, and home and office heating units.

Permanent Oil and Gas Facilities: Permanent Facilities include production facilities, pipelines, roads, airstrips, production pads, docks and other bottom-founded structures, seawater-treatment plants, and other structures associated with an oil and gas operation that occupy land for more than one winter season; also included are material sites such as sand and gravel, and "temporary platforms" if those platforms are used for production rather than exploration. Exploration wellheads and seasonal facilities such as ice roads and ice pads are excluded, even when the pads are designed for use in successive winters. This definition does not include over-summering ice pads for exploration purposes.

Setback: A distance measured from a named ground feature, such as a river or lake, in which certain activities or structures would not be allowed. All setback distances are to be measured as of the time of the application for a permit for a development. In addition, facility development along the coast would be required to be designed to maintain the prescribed setback distance for the anticipated life of the facility.

SO_x: Sulfur oxides, including sulfur dioxide (SO_2). A product of vehicle tailpipe emissions.

Stipulation: A requirement or condition placed by the Bureau of Land Management on the leaseholder for operations the leaseholder might carry out within that lease. The Bureau of Land Management develops stipulations that apply to all future leases within the National Petroleum Reserve-Alaska.

Temporary Platform: A facility that does not require the use of an ice or gravel pad to support oil and gas and related exploration activities. An example of a temporary platform recently used on the North Slope is Anadarko Petroleum's Arctic Drilling Platform used for the company's Hot Ice Project during the winters of 2003-2004. The facility consisted of a series of platform modules joined together and supported above the tundra

surface on steel legs. Once the project was completed the platform was disassembled and the support legs were removed, leaving the tundra surface undisturbed. Note: A temporary platform that is used for production, as opposed to exploration, would be considered a permanent oil and gas facility and be subject to the restrictions on placement of such structures.

Valid existing: in the context of exceptions for the development of "valid existing NPR-A oil and gas leases," "valid existing" leases refers to oil and gas leases issued by the BLM prior to the signing of this record of decision and valid at the time of the application for approval of an action for which the "valid existing NPR-A oil and gas lease" exception is requested.

Volatile Organic Compounds (VOCs): A group of chemicals that react in the atmosphere with nitrogen oxides in the presence of sunlight and heat to form ozone. VOCs contribute significantly to photochemical smog production and certain health problems. Examples of VOCs are gasoline fumes and oil-based paints.

Applicability of Requirements/Standards

All surface disturbing activities such as exploratory drilling, road/pipeline construction, seismic acquisition, and overland moves require additional authorization(s) issued subsequent to leasing. The stipulations and best management practices require that certain protections of resources and uses be achieved. Requirements and standards listed with the stipulations and best management practices represent BLM's current understanding of how lessees/permittees would achieve the objectives of the stipulation or best management practice.

A lessee/permittee may propose a deviation from the requirements/standards of stipulations and best management practices as part of an authorization application. Prior to approving an alternative procedure as part of the authorization, BLM's staff would analyze the proposal and determine if the proposal incorporating the alternative procedure would achieve the objectives of the stipulations and best management practices. If the BLM determines that the alternative procedure proposed by the applicant would meet the stipulation's or best management practice's objective, BLM could approve the alternative procedure. If BLM determines that the alternative procedure proposed by the applicant is unlikely to meet the objectives of a

stipulation or best management practice, the requirements/standards would still be required. However, the authorized officer may allow a deviation from the objectives and requirement/standard in a new decision document supported by additional NEPA analysis.

The BLM could independently require different actions than those listed under requirements/standards. If, after experience or additional study, BLM concludes that a requirement/standard is not achieving or is unlikely to achieve the protective objective when applied to a specific future on-the-ground action or would not do so as well as the use of recently proven technology or techniques, BLM could at the permitting stage and under the terms of the stipulation or best management practice, impose other restrictions to meet the objective.

Stipulations and Best Management Practices

Waste Prevention, Handling, Disposal, Spills, Air Quality, and Public Health and Safety

A-1 Best Management Practice

Objective: Protect the health and safety of oil and gas field workers and the general public by disposing of solid waste and garbage in accordance with applicable federal, State, and local law and regulations.
Requirement/Standard: Areas of operation shall be left clean of all debris.

A-2 Best Management Practice

Objective: Minimize impacts on the environment from non-hazardous and hazardous waste generation. Encourage continuous environmental improvement. Protect the health and safety of oil field workers and the general public. Avoid human-caused changes in predator populations.
Requirement/Standard: Lessees/permittees shall prepare and implement a comprehensive waste management plan for all phases of exploration and development, including seismic activities. The plan shall be submitted to the authorized officer for approval, in consultation with federal, State, and North Slope Borough regulatory and resource agencies, as appropriate (based on agency legal authority and jurisdictional responsibility), as part of a plan of operations or other similar permit application.
Management decisions affecting waste generation shall be addressed in the following order of priority: 1) prevention and reduction, 2) recycling, 3)

treatment, and 4) disposal. The plan shall consider and take into account the following requirements:

a. Methods to avoid attracting wildlife to food and garbage. The plan shall identify precautions that are to be taken to avoid attracting wildlife to food and garbage
b. Disposal of putrescible waste. Requirements prohibit the burial of garbage. Lessees and permitted users shall have a written procedure to ensure that the handling and disposal of putrescible waste will be accomplished in a manner that prevents the attraction of wildlife. All putrescible waste shall be incinerated, backhauled, or composted in a manner approved by the authorized officer. All solid waste, including incinerator ash, shall be disposed of in an approved waste-disposal facility in accordance with EPA and Alaska Department of Environmental Conservation regulations and procedures. The burial of human waste is prohibited except as authorized by the authorized officer.
c. Disposal of pumpable waste products. Except as specifically provided, the BLM requires that all pumpable solid, liquid, and sludge waste be disposed of by injection in accordance with EPA, Alaska Department of Environmental Conservation, and the Alaska Oil and Gas Conservation Commission regulations and procedures. On-pad temporary muds and cuttings storage, as approved by Alaska Department of Environmental Conservation, will be allowed as necessary to facilitate annular injection and/or backhaul operations.
d. Disposal of wastewater and domestic wastewater. The BLM prohibits wastewater discharges or disposal of domestic wastewater into bodies of fresh, estuarine, and marine water, including wetlands, unless authorized by a National Pollutant Discharge Elimination System or State permit.

A-3 Best Management Practice

Objective: Minimize pollution through effective hazardous-materials contingency planning.

Requirement/Standard: For oil- and gas-related activities, a hazardous materials emergency contingency plan shall be prepared and implemented before transportation, storage, or use of fuel or hazardous substances. The plan shall include a set of procedures to ensure prompt response, notification, and cleanup in the event of a hazardous substance spill or threat of a release. Procedures in the plan applicable to fuel and hazardous substances handling (associated with transportation vehicles) shall consist of

best management practices if approved by the authorized officer. The plan shall include a list of resources available for response (e.g., heavy-equipment operators, spill-cleanup materials or companies), and names and phone numbers of federal, State, and North Slope Borough contacts. Other federal and State regulations may apply and require additional planning requirements. All appropriate staff shall be instructed regarding these procedures. In addition contingency plans related to facilities developed for oil production shall include requirements to:

a. provide refresher spill-response training to North Slope Borough and local community spill-response teams on a yearly basis,
b. plan and conduct a major spill-response field-deployment drill annually,
c. prior to production and as required by law, develop spill prevention and response contingency plans and participate in development and maintenance of the North Slope Subarea Contingency Plan for Oil and Hazardous Substances Discharges/Releases for the National Petroleum Reserve-Alaska operating area. Planning shall include development and funding of detailed (e.g., 1:26,000 scale) environmental sensitivity index maps for the lessee's/permittee's operating area and areas outside the lessee's/permittee's operating area that could be affected by their activities. (The specific area to be mapped shall be defined in the lease agreement and approved by the authorized officer in consultation with appropriate resource agencies.) Maps shall be completed in paper copy and geographic information system format in conformance with the latest version of the U.S. Department of Commerce, National Oceanic and Atmospheric Administration's Environmental Sensitivity Index Guidelines. Draft and final products shall be peer reviewed and approved by the authorized officer in consultation with appropriate federal, State, and North Slope Borough resource and regulatory agencies.

A-4 Best Management Practice

Objective: Minimize the impact of contaminants on fish, wildlife, and the environment, including wetlands, marshes and marine waters, as a result of fuel, crude oil, and other liquid chemical spills. Protect subsistence resources and subsistence activities. Protect public health and safety.

Requirement/Standard: Before initiating any oil and gas or related activity or operation, including field research/surveys and/or seismic operations, lessees/permittees shall develop a comprehensive spill prevention and

response contingency plan per 40 CFR § 112 (Oil Pollution Act). The plan shall consider and take into account the following requirements:

a. On-site Clean-up Materials. Sufficient oil-spill-cleanup materials (absorbents, containment devices, etc.) shall be stored at all fueling points and vehicle-maintenance areas and shall be carried by field crews on all overland moves, seismic work trains, and similar overland moves by heavy equipment.
b. Storage Containers. Fuel and other petroleum products and other liquid chemicals shall be stored in proper containers at approved locations. Except during overland moves and seismic operations, fuel, other petroleum products, and other liquid chemicals designated by the authorized officer that in total exceed 1,320 gallons shall be stored within an impermeable lined and diked area or within approved alternate storage containers, such as over packs, capable of containing 110% of the stored volume. In areas within 500 feet of water bodies, fuel containers are to be stored within appropriate containment.
c. Liner Materials. Liner material shall be compatible with the stored product and capable of remaining impermeable during typical weather extremes expected throughout the storage period.
d. Permanent Fueling Stations. Permanent fueling stations shall be lined or have impermeable protection to prevent fuel migration to the environment from overfills and spills.
e. Proper Identification of Containers. All fuel containers, including barrels and propane tanks, shall be marked with the responsible party's name, product type, and year filled or purchased.
f. Notice of Reportable Spills. Notice of any reportable spill (as required by 40 CFR § 300.125 and 18 AAC § 75.300) shall be given to the authorized officer as soon as possible, but no later than 24 hours after occurrence.
g. Identification of Oil Pans *("duck ponds")*. All oil pans shall be marked with the responsible party's name.

A-5 Best Management Practice

Objective: Minimize the impact of contaminants from refueling operations on fish, wildlife and the environment.

Requirement/Standard: Refueling of equipment within 500 feet of the active floodplain of any water body is prohibited. Fuel storage stations shall be located at least 500 feet from any water body with the exception that small caches (up to 210 gallons) for motor boats, float planes, ski planes, and small equipment, e.g. portable generators and water pumps, are permitted.

The authorized officer may allow storage and operations at areas closer than the stated distances if properly designed to account for local hydrologic conditions.

A-6 Best Management Practice

Objective: Minimize the impact on fish, wildlife, and the environment from contaminants associated with the exploratory drilling process.

Requirement/Standard: Surface discharge of reserve-pit fluids is prohibited.

A-7 Best Management Practice

Objective: Minimize the impacts to the environment of disposal of produced fluids recovered during the development phase on fish, wildlife, and the environment.

Requirement/Standard: Discharge of produced water in upland areas and marine waters is prohibited.

A-8 Best Management Practice

Objective: Minimize conflicts resulting from interaction between humans and bears during oil and gas activities.

Requirement/Standard: Oil and gas lessees and their contractors and subcontractors will, as a part of preparation of lease operation planning, prepare and implement bear-interaction plans to minimize conflicts between bears and humans. These plans shall include measures to:

a. Minimize attraction of bears to the drill sites.
b. Organize layout of buildings and work sites to minimize human/bear interactions.
c. Warn personnel of bears near or on work sites and identify proper procedures to be followed.
d. Establish procedures, if authorized, to discourage bears from approaching the work site.
e. Provide contingencies in the event bears do not leave the site or cannot be discouraged by authorized personnel.
f. Discuss proper storage and disposal of materials that may be toxic to bears.
g. Provide a systematic record of bears on the work site and in the immediate area.

A-9 Best Management Practice
Objective: Reduce air quality impacts.
Requirement/Standard: All oil and gas operations (vehicles and equipment) that burn diesel fuels must use "ultra-low sulfur" diesel as defined by the Alaska Department of Environmental Conservation-Division of Air Quality.

A-10 Best Management Practice
Objective: Prevent unnecessary or undue degradation of the lands and protect health.
Requirement/Standard: This measure includes the following elements:

a. Prior to initiation of a NEPA analysis for an application to develop a central production facility, production pad/well, airstrip, road, gas compressor station, or other potential substantial air pollutant emission source (hereafter project), the authorizing officer (BLM) may require the project proponent to provide a minimum of one year of baseline ambient air monitoring data for any pollutant(s) of concern as determined by BLM if no representative air monitoring data are available for the project area, or existing representative ambient air monitoring data are insufficient, incomplete, or do not meet minimum air monitoring standards set by the Alaska DEC or the EPA. If BLM determines that baseline monitoring is required, this pre-analysis data must meet Alaska DEC and EPA air monitoring standards, and cover the year immediately prior to the submittal. Pre-project monitoring may not be appropriate where the life of the project is less than one year.
b. The BLM may require monitoring for the life of the project depending on the magnitude of potential air emissions from the project, proximity to a federally mandated Class I area, sensitive Class II area (as identified on a case-by-case basis by Alaska DEC or a federal land management agency), or population center, location within or proximity to a non-attainment or maintenance area, meteorological or geographic conditions, existing air quality conditions, magnitude of existing development in the area, or issues identified during NEPA undertaken for the project.
c. For an application to develop a central production facility, production pad/well, airstrip, road, gas compressor station, or other potential substantial air pollutant emission source, the project proponent shall prepare (and submit for BLM approval) an emissions inventory that includes quantified emissions of regulated air pollutants from all direct and indirect sources related to the proposed project, including

reasonably foreseeable air pollutant emissions of criteria air pollutants, volatile organic compounds, hazardous air pollutants, and greenhouse gases estimated for each year for the life of the project. The BLM will use this estimated emissions inventory to identify pollutants of concern and to determine the appropriate level of air analysis to be conducted for the proposed project.

d. For an application to develop a central production facility, production pad/well, airstrip, road, gas compressor station, or other potential substantial air pollutant emission source, the BLM may require the proponent to provide an emissions reduction plan that includes a detailed description of operator committed measures to reduce project related air pollutant emissions including, but not limited to greenhouse gases and fugitive dust.

e. For an application to develop a central production facility, production pad/well, airstrip, road, gas compressor station, or other potential substantial air pollutant emission source, the authorized officer may require air quality modeling for purposes of analyzing project direct, indirect or cumulative impacts to air quality. The BLM may require air quality modeling depending on the magnitude of potential air emissions from the project or activity, duration of the proposed action, proximity to a federally mandated Class I area, sensitive Class II area (as identified on a case-by-case basis by Alaska DEC or a federal land management agency), or population center, location within a non-attainment or maintenance area, meteorological or geographic conditions, existing air quality conditions, magnitude of existing development in the area, or issues identified during NEPA undertaken for the project. The BLM will determine the information required for a project specific modeling analysis through the development of a modeling protocol for each analysis. The authorized officer will consult with appropriate federal, State, and/or local agencies regarding modeling to inform his/her modeling decision and avoid duplication of effort. The modeling shall compare predicted impacts to all applicable local, State, and federal air quality standards and increments, as well as other scientifically defensible significance thresholds (such as impacts to air quality related values, incremental cancer risks, etc.).

f. The BLM may require air quality mitigation measures and strategies within its authority (and in consultation with local, state, federal, and tribal agencies with responsibility for managing air resources) in addition to regulatory requirements and proponent committed

emission reduction measures, and for emission sources not otherwise regulated by Alaska DEC or EPA, if the air quality analysis shows potential future impacts to NAAQS or AAAQS or impacts above specific levels of concern for air quality related values (AQRVs).

g. If ambient air monitoring indicates that project-related emissions are causing or contributing to impacts that would cause unnecessary or undue degradation of the lands, cause exceedances of NAAQS, or fail to protect health (either directly or through use of subsistence resources), the authorized officer may require changes in activities at any time to reduce these emissions to comply with the NAAQS and/or minimize impacts to AQRVs. Within the scope of BLM's authority, the BLM may require additional emission control strategies to minimize or reduce impacts to air quality.
h. Publicly available reports on air quality baseline monitoring, emissions inventory, and modeling results developed in conformance with this best management procedure shall be provided by the project proponent to the North Slope Borough and to local communities and Tribes in a timely manner.

A-11 Best Management Practice

Objective: Ensure that permitted activities do not create human health risks through contamination of subsistence foods.

Requirement/Standard: A lessee proposing a permanent oil and gas development shall design and implement a monitoring study of contaminants in locally-used subsistence foods. The monitoring study shall examine subsistence foods for all contaminants that could be associated with the proposed development. The study shall identify the level of contaminants in subsistence foods prior to the proposed permanent oil and gas development and monitor the level of these contaminants throughout the operation and abandonment phases of the development. If ongoing monitoring detects a measurable and persistent increase in a contaminant in subsistence foods, the lessee shall design and implement a study to determine how much, if any, of the increase in the contaminant in subsistence foods originates from the lessee's activities. If the study determines that a portion of the increase in contamination in subsistence foods is caused by the lessee's activities, the authorized officer may require changes in the lessee's processes to reduce or eliminate emissions of the contaminant. The design of the study/studies must meet the approval of the authorized officer. The authorized officer may consult with appropriate federal, State, and North Slope Borough agencies prior to approving the study/studies design. The authorized officer may

require/authorize changes in the design of the studies throughout the operations and abandonment period, or terminate or suspend studies if results warrant.

A-12 Best Management Practice

Objective: To minimize negative health impacts associated with oil spills.

Requirement/Standard: If an oil spill with potential impacts to public health occurs, the BLM, in undertaking its oil spill responsibilities, will consider:

a. Immediate health impacts and responses for affected communities and individuals.
b. Long-term monitoring for contamination of subsistence food sources.
c. Long-term monitoring of potential human health impacts.
d. Perceptions of contamination and subsequent changes in consumption patterns.
e. Health promotion activities and communication strategies to maintain the consumption of traditional food.

Water Use for Permitted Activities

B-1 Best Management Practice

Objective: Maintain populations of, and adequate habitat for, fish and invertebrates.

Requirement/Standard: Withdrawal of unfrozen water from rivers and streams during winter is prohibited. The removal of ice aggregate from grounded areas ≤4-feet deep may be authorized from rivers on a site-specific basis.

B-2 Best Management Practice

Objective: Maintain natural hydrologic regimes in soils surrounding lakes and ponds, and maintain populations of, and adequate habitat for, fish, invertebrates, and waterfowl.

Requirement/Standard: Withdrawal of unfrozen water from lakes and the removal of ice aggregate from grounded areas ≤4-feet deep may be authorized on a site-specific basis depending on water volume and depth and the waterbody's fish community. Current water use requirements are:

a. Lakes with sensitive fish (i.e., any fish except ninespine stickleback or Alaska blackfish): unfrozen water available for withdrawal is limited to 15% of calculated volume deeper than 7 feet; only ice aggregate may be removed from lakes that are ≤7-feet deep.

b. Lakes with only non-sensitive fish (i.e., ninespine stickleback or Alaska blackfish): unfrozen water available for withdrawal is limited to 30% of calculated volume deeper than 5 feet; only ice aggregate may be removed from lakes that are ≤5.
c. Lakes with no fish present, regardless of depth: water available for use is limited to 35% of total lake volume.
d. In lakes where unfrozen water and ice aggregate are both removed, the total use shall not exceed the respective 15%, 30%, or 35% volume calculations.
e. Additional modeling or monitoring may be required to assess water level and water quality conditions before, during, and after water use from any fish-bearing lake or lake of special concern.
f. Any water intake structures in fish bearing or non-fish bearing waters shall be designed, operated, and maintained to prevent fish entrapment, entrainment, or injury. Note: All water withdrawal equipment must be equipped and must utilize fish screening devices approved by the Alaska Department of Fish and Game, Division of Habitat.
g. Compaction of snow cover or snow removal from fish-bearing waterbodies shall be prohibited except at approved ice road crossings, water pumping stations on lakes, or areas of grounded ice.

Winter Overland Moves and Seismic Work

The following best management practices apply to overland moves, seismic work, and any similar cross-country vehicle use of heavy equipment on non-roaded surfaces during the winter season. These restrictions do not apply to the use of such equipment on ice roads after they are constructed.

C-1 Best Management Practice
Objective: Protect grizzly bear, polar bear, and marine mammal denning and/or birthing locations.
Requirement/Standard:

a. Cross-country use of heavy equipment and seismic activities is prohibited within ½ mile of occupied grizzly bear dens identified by the Alaska Department of Fish and Game unless alternative protective measures are approved by the authorized officer in consultation with the Alaska Department of Fish and Game.
b. Cross-country use of heavy equipment and seismic activity is prohibited within 1 mile of known or observed polar bear dens or seal

birthing lairs. Operators near coastal areas shall conduct a survey for potential polar bear dens and seal birthing lairs and consult with the USFWS and/or NOAA-Fisheries, as appropriate, before initiating activities in coastal habitat between October 30 and April 15.

C-2 Best Management Practice

Objective: Protect stream banks, minimize compaction of soils, and minimize the breakage, abrasion, compaction, or displacement of vegetation.

Requirement/Standard:

a. Ground operations shall be allowed only when frost and snow cover are at sufficient depths to protect the tundra. Ground operations shall cease when the spring snowmelt begins (approximately May 5 in the foothills area where elevations reach or exceed 500 feet and approximately May 15 in the northern coastal areas). The exact dates will be determined by the authorized officer.
b. Low-ground-pressure vehicles shall be used for on-the-ground activities off ice roads or pads. Low-ground-pressure vehicles shall be selected and operated in a manner that eliminates direct impacts to the tundra by shearing, scraping, or excessively compacting the tundra mat. Note: This provision does not include the use of heavy equipment such as front-end loaders and similar equipment required during ice road construction.
c. Bulldozing of tundra mat and vegetation, trails, or seismic lines is prohibited; however, on existing trails, seismic lines or camps, clearing of drifted snow is allowed to the extent that the tundra mat is not disturbed.
d. To reduce the possibility of ruts, vehicles shall avoid using the same trails for multiple trips unless necessitated by serious safety or superseding environmental concern. This provision does not apply to hardened snow trails for use by low-ground-pressure vehicles such as Rolligons.
e. The location of ice roads shall be designed and located to minimize compaction of soils and the breakage, abrasion, compaction, or displacement of vegetation. Offsets may be required to avoid using the same route or track in the subsequent year.
f. Motorized ground-vehicle use within the Colville River Special Area associated with overland moves, seismic work, and any similar use of heavy equipment shall be minimized within an area that extends 1 mile west or northwest of the bluffs of the Colville River, and 2 miles on either side of the Kogosukruk and Kikiakrorak rivers and

tributaries of the Kogosukruk River from April 15 through August 5, with the exception that use will be minimized in the vicinity of gyrfalcon nests beginning March 15. Such use will remain 1/2 mile away from known raptor nesting sites, unless authorized by the authorized officer.

C-3 Best Management Practice

Objective: Maintain natural spring runoff patterns and fish passage, avoid flooding, prevent streambed sedimentation and scour, protect water quality, and protect stream banks.

Requirement/Standard: Crossing of waterway courses shall be made using a low-angle approach. Crossings that are reinforced with additional snow or ice ("bridges") shall be removed, breached, or slotted before spring breakup. Ramps and bridges shall be substantially free of soil and debris.

C-4 Best Management Practice

Objective: Avoid additional freeze-down of deep-water pools harboring over-wintering fish and invertebrates used by fish.

Requirement/Standard: Travel up and down streambeds is prohibited unless it can be demonstrated that there will be no additional impacts from such travel to over-wintering fish or the invertebrates they rely on. Rivers, streams, and lakes shall be crossed at areas of grounded ice whenever possible.

C-5 Best Management Practice

Objective: Minimize the effects of high-intensity acoustic energy from seismic surveys on fish.

Requirement/Standard:

a. When conducting vibroseis-based surveys above potential fish overwintering areas (water 6 feet deep or greater, ice plus liquid depth), operators shall follow recommendations by Morris and Winters (2005): only a single set of vibroseis shots should be conducted if possible; if multiple shot locations are required, these should be conducted with minimal delay; multiple days of vibroseis activity above the same overwintering area should be avoided if possible.
b. When conducting air gun-based surveys in freshwater, operators shall follow standard marine mitigation measures that are applicable to fish (e.g., Minerals Management Service 2006): operators will use the lowest sound levels feasible to accomplish their data-collection needs;

ramp-up techniques will be utilized (ramp-up involves the gradual increase in emitted sound levels beginning with firing a single air gun and gradually adding air guns until the desired operating level of the full array is obtained).

c. When conducting explosive-based surveys, operators shall follow setback distances from fish-bearing waterbodies based on requirements outlined by Alaska Department of Fish and Game (1991).

Oil and Gas Exploratory Drilling

D-1 Lease Stipulation

Objectives: Protect fish-bearing rivers, streams, and lakes from blowouts and minimize alteration of riparian habitat.

Requirement/Standard: Exploratory drilling is prohibited in rivers and streams, as determined by the active floodplain, and fish-bearing lakes.

D-2 Lease Stipulation

Objective: Minimize surface impacts from exploratory drilling.

Requirement/Standard: Construction of permanent or gravel oil and gas facilities shall be prohibited for exploratory drilling. Use of a previously constructed road or pad may be permitted if it is environmentally preferred.

Facility Design and Construction

E-1 Best Management Practice

Objective: Protect subsistence use and access to subsistence hunting and fishing areas and minimize the impact of oil and gas activities on air, land, water, fish, and wildlife resources.

Requirement/Standard: All roads must be designed, constructed, maintained, and operated to create minimal environmental impacts and to protect subsistence use and access to subsistence hunting and fishing areas. The authorized officer will consult with appropriate federal, State, and North Slope Borough regulatory and resources agencies prior to approving construction of roads. Subject to approval by the authorized officer, the construction, operation, and maintenance of oil and gas field roads is the responsibility of the lessee unless the construction, operation, and maintenance of roads are assumed by the appropriate governing entity.

E-2 Lease Stipulation

Objective: Protect fish-bearing water bodies, water quality, and aquatic habitats.

Requirement/Standard: Permanent oil and gas facilities, including roads, airstrips, and pipelines, are prohibited upon or within 500 feet as measured from the ordinary high water mark of fish-bearing waterbodies. Essential pipeline and road crossings will be permitted on a case-by-case basis. Note: Also refer to Stipulations/Best Management Practices K-1 and K-2. Construction camps are prohibited on frozen lakes and river ice. Siting of construction camps on river sand and gravel bars is allowed and encouraged. Where leveling of trailers or modules is required and the surface has a vegetative mat, leveling shall be accomplished through blocking rather than use of a bulldozer.

E-3 Lease Stipulation

Objective: Maintain free passage of marine and anadromous fish and protect subsistence use and access to subsistence hunting and fishing.

Requirement/Standard: Causeways and docks are prohibited in river mouths or deltas. Artificial gravel islands and bottom-founded structures are prohibited in river mouths or active stream channels on river deltas. Causeways, docks, artificial islands, and bottom-founded drilling structures shall be designed to ensure free passage of marine and anadromous fish and to prevent significant changes to nearshore oceanographic circulation patterns and water quality characteristics. A monitoring program, developed in consultation with appropriate federal, State, and North Slope Borough regulatory and resource agencies, shall be required to address the objectives of water quality and free passage of fish.

E-4 Best Management Practice

Objective: Minimize the potential for pipeline leaks, the resulting environmental damage, and industrial accidents.

Requirement/Standard: All pipelines shall be designed, constructed, and operated under an authorized officer-approved Quality Assurance/Quality Control plan that is specific to the product transported and shall be constructed to accommodate the best available technology for detecting and preventing corrosion or mechanical defects during routine structural integrity inspections.

E-5 Best Management Practice

Objective: Minimize impacts of the development footprint.

Requirement/Standard: Facilities shall be designed and located to minimize the development footprint. Issues and methods that are to be considered include:

a. use of maximum extended-reach drilling for production drilling to minimize the number of pads and the network of roads between pads;
b. sharing facilities with existing development;
c. collocation of all oil and gas facilities, except airstrips, docks, and seawater-treatment plants, with drill pads;
d. integration of airstrips with roads;
e. use of gravel-reduction technologies, e.g., insulated or pile-supported pads,
f. coordination of facilities with infrastructure in support of offshore development.

Note: Where aircraft traffic is a concern, consideration shall be given to balancing gravel pad size and available supply storage capacity with potential reductions in the use of aircraft to support oil and gas operations.

E-6 Best Management Practice

Objective: Reduce the potential for ice-jam flooding, impacts to wetlands and floodplains, erosion, alteration of natural drainage patterns, and restriction of fish passage.

Requirement/Standard: Stream and marsh crossings shall be designed and constructed to ensure free passage of fish, reduce erosion, maintain natural drainage, and minimize adverse effects to natural stream flow. Note: Bridges, rather than culverts, are the preferred method for crossing rivers. When necessary, culverts can be constructed on smaller streams, if they are large enough to avoid restricting fish passage or adversely affecting natural stream flow.

E-7 Best Management Practice

Objective: Minimize disruption of caribou movement and subsistence use.

Requirement/Standard: Pipelines and roads shall be designed to allow the free movement of caribou and the safe, unimpeded passage of the public while participating in subsistence activities. Listed below are the accepted design practices:

a. Above ground pipelines shall be elevated a minimum of 7 feet as measured from the ground to the bottom of the pipeline at vertical support members.

b. In areas where facilities or terrain may funnel caribou movement, ramps over pipelines, buried pipelines, or pipelines buried under roads may be required by the authorized officer after consultation with federal, State, and North Slope Borough regulatory and resource agencies (as appropriate, based on agency legal authority and jurisdictional responsibility).
c. A minimum distance of 500 feet between pipelines and roads shall be maintained. Separating roads from pipelines may not be feasible within narrow land corridors between lakes and where pipelines and roads converge on a drill pad. Where it is not feasible to separate pipelines and roads, alternative pipeline routes, designs and possible burial within the road will be considered by the authorized officer.

E-8 Best Management Practice

Objective: Minimize the impact of mineral materials mining activities on air, land, water, fish, and wildlife resources.

Requirement/Standard: Gravel mine site design and reclamation will be in accordance with a plan approved by the authorized officer. The plan shall be developed in consultation with appropriate federal, State, and North Slope Borough regulatory and resource agencies and consider:

a. Locations outside the active flood plain.
b. Design and construction of gravel mine sites within active flood plains to serve as water reservoirs for future use.
c. Potential use of the site for enhancing fish and wildlife habitat.
d. Potential storage and reuse of sod/overburden for the mine site or at other disturbed sites on the North Slope.

E-9 Best Management Practice

Objective: Avoidance of human-caused increases in populations of predators of ground nesting birds.

Requirement/Standard:

a. Lessee shall utilize best available technology to prevent facilities from providing nesting, denning, or shelter sites for ravens, raptors, and foxes. The lessee shall provide the authorized officer with an annual report on the use of oil and gas facilities by ravens, raptors, and foxes as nesting, denning, and shelter sites.
b. Feeding of wildlife is prohibited and will be subject to non-compliance regulations.

E-10 Best Management Practice

Objective: Prevention of migrating waterfowl, including species listed under the Endangered Species Act, from striking oil and gas and related facilities during low light conditions.

Requirement/Standard: Illumination of all structures between August 1 and October 31 shall be designed to direct artificial exterior lighting inward and downward, rather than upward and outward, unless otherwise required by the Federal Aviation Administration.

E-11 Best Management Practice

Objective: Minimize the take of species, particularly those listed under the Endangered Species Act and BLM Special Status Species, from direct or indirect interaction with oil and gas facilities.

Requirement/Standard: In accordance with the guidance below, before the approval of facility construction, aerial surveys of the following species shall be conducted within any area proposed for development.

Special Conditions in Spectacled and/or Steller's Eiders Habitats:

a. Surveys shall be conducted by the lessee for at least 3 years before authorization of construction, if such construction is within the USFWS North Slope eider survey area and at least 1 year outside that area. Results of aerial surveys and habitat mapping may require additional ground nest surveys. Spectacled and/or Steller's eider surveys shall be conducted following accepted BLM-protocol. Information gained from these surveys shall be used to make infrastructure siting decisions as discussed in subparagraph b, below.
b. If spectacled and/or Steller's eiders are determined to be present within the proposed development area, the applicant shall work with the USFWS and BLM early in the design process to site roads and facilities in order to minimize impacts to nesting and brood-rearing eiders and their preferred habitats. Such consultation shall address timing restrictions and other temporary mitigating measures, location of permanent facilities, placement of fill, alteration of eider habitat, aircraft operations, and management of high noise levels.
c. To reduce the possibility of spectacled and/or Steller's eiders or other birds colliding with above-ground utility lines (power and communication), such lines shall either be buried in access roads or suspended on vertical support members except in rare cases which are to be few in number and limited in extent. Exceptions are limited to the following situations, and must be reported to the USFWS when exceptions are authorized:

1. Overhead power or communication lines may be allowed when located entirely within the boundaries of a facility pad;
2. Overhead power or communication lines may be allowed when engineering constraints at the specific and limited location make it infeasible to bury or connect the lines to a vertical support member; or
3. Overhead power or communication lines may be allowed in situations when human safety would be compromised by other methods.

d. To reduce the likelihood of spectacled and/or Steller's eiders or other birds colliding with communication towers, towers should be located, to the extent practicable, on existing pads and as close as possible to buildings or other structures, and on the east or west side of buildings or other structures if possible. Support wires associated with communication towers, radio antennas, and other similar facilities, should be avoided to the extent practicable. If support wires are necessary, they should be clearly marked along their entire length to improve visibility to low flying birds. Such markings shall be developed through consultation with the USFWS.

Special Conditions in Yellow-billed Loon Habitats:

e. Aerial surveys shall be conducted by the lessee for at least 3 years before authorization of construction of facilities proposed for development which are within 1 mile of a lake 25 acres or larger in size. These surveys along shorelines of large lakes shall be conducted following accepted BLM protocol during nesting in late June and during brood rearing in late August.

f. Should yellow-billed loons be present, the design and location of facilities must be such that disturbance is minimized. The default standard mitigation is a 1-mile buffer around all recorded nest sites and a minimum 1,625-foot (500-meter) buffer around the remainder of the shoreline. Development will generally be prohibited within buffers unless no other option exists.

Protections for Birds

g. To reduce the possibility of birds colliding with above-ground utility lines (power and communication), such lines shall either be buried in access roads or suspended on vertical support members except in rare cases, which are to be few in number and limited in extent. Exceptions are limited to the following situations:
1. Overhead power or communication lines may be allowed when located entirely within the boundaries of a facility pad;

2. Overhead power or communication lines may be allowed when engineering constraints at the specific and limited location make it infeasible to bury or connect the lines to a vertical support member; or
3. Overhead power or communication lines may be allowed in situations when human safety would be compromised by other methods.

h. To reduce the likelihood of birds colliding with communication towers, towers should be located, to the extent practicable, on existing pads and as close as possible to buildings or other structures, and on the east or west side of buildings or other structures if possible. Support wires associated with communication towers, radio antennas, and other similar facilities, should be avoided to the extent practicable. If support wires are necessary, they should be clearly marked along their entire length to improve visibility to low-flying birds. Such markings shall be developed through consultation with the USFWS.

E-12 Best Management Practice

Objective: Use ecological mapping as a tool to assess wildlife habitat before development of permanent facilities to conserve important habitat types during development.

Requirement/Standard: An ecological land classification map of the development area shall be developed before approval of facility construction. The map will integrate geomorphology, surface form, and vegetation at a scale, level of resolution, and level of positional accuracy adequate for detailed analysis of development alternatives. The map shall be prepared in time to plan one season of ground-based wildlife surveys, if deemed necessary by the authorized officer, before approval of the exact facility location and facility construction.

E-13 Best Management Practice

Objective: Protect cultural and paleontological resources.

Requirement/Standard: Lessees shall conduct a cultural and paleontological resources survey prior to any ground-disturbing activity. Upon finding any potential cultural or paleontological resource, the lessee or their designated representative shall notify the authorized officer and suspend all operations in the immediate area of such discovery until written authorization to proceed is issued by the authorized officer.

E-14 Best Management Practice
Objective: Ensure the passage of fish at stream crossings.
Requirement/Standard: To ensure that crossings provide for fish passage, all proposed crossing designs shall adhere to the best management practices outlined in "Stream Crossing Design Procedure for Fish Streams on the North Slope Coastal Plain" by McDonald et al. (1994), "Fundamentals of Culvert Design for Passage of Weak-Swimming Fish" by Behlke et al. (1991), and other generally accepted best management procedures prescribed by the authorized officer. To adhere to these best management practices, at least 3 years of hydrologic and fish data shall be collected by the lessee for any proposed crossing of a stream whose structure is designed to occur, wholly or partially, below the stream's ordinary high watermark. These data shall include, but are not limited to, the range of water levels (highest and lowest) at the location of the planned crossing, and the seasonal distribution and composition of fish populations using the stream.

E-15 Best Management Practice
Objective: Prevent or minimize the loss of nesting habitat for cliff nesting raptors.
Requirement/Standard:

a. Removal of greater than 100 cubic yards of bedrock outcrops, sand, and/or gravel from cliffs shall be prohibited.
b. Any extraction of sand and/or gravel from an active river or stream channel shall be prohibited unless preceded by a hydrological study that indicates no potential impact by the action to the integrity of the river bluffs.

E-16 Best Management Practice
Objective: Prevent or minimize the loss of raptors due to electrocution by power lines.
Requirement/Standard: Comply with the most up-to-date industry-accepted suggested practices for raptor protection on power lines. Current accepted standards were published in *Reducing Avian Collisions with Power Lines: The State of the Art in 2012* by the Avian Power Line Interaction Committee and are updated as needed.

E-17 Best Management Practice
Objective: Manage permitted activities to meet Visual Resource Management class objectives described below.

Class I: Natural ecological changes and very limited management activity are allowed. The level of change to the characteristic landscape should be very low and must not attract attention.

Class II: The level of change to the characteristic landscape should be low. Management activities may be seen, but should not dominate the view of the casual observer. Any changes should repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.

Class III: The level of change to the characteristic landscape should be moderate. Management activities may attract attention, but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape.

Class IV: The level of change to the characteristic landscape can be high. These management activities may dominate the view and be the major focus of viewer attention. However, every attempt should be made to minimize impacts through location and design by repeating form, line, color, and texture.

Requirement/Standard: At the time of application for construction of permanent facilities, the lessee/permittee shall, after consultation with the authorized officer, submit a plan to best minimize visual impacts, consistent with the Visual Resource Management class for the lands on which facilities would be located. A photo simulation of the proposed facilities may be a necessary element of the plan.

E-18 Best Management Practice

Objective: Avoid and reduce temporary impacts to productivity from disturbance near Steller's and/or spectacled eider nests.

Requirement/Standard: Ground-level activity (by vehicle or on foot) within 200 meters of occupied Steller's and/or spectacled eider nests, from June 1 through August 15, will be restricted to existing thoroughfares, such as pads and roads. Construction of permanent facilities, placement of fill, alteration of habitat, and introduction of high noise levels within 200 meters of occupied Steller's and/or spectacled eider nests will be prohibited. In instances where summer (June 1 through August 15) support/construction activity must occur off existing thoroughfares, USFWS-approved nest surveys must be conducted during mid-June prior to the approval of the activity. Collected data will be used to evaluate whether the action could occur based on employment of a 200-meter buffer around nests or if the activity would be delayed until after mid-August once ducklings are mobile

and have left the nest site. Also, in cases in which oil spill response training is proposed to be conducted within 200 meters of shore in riverine, marine, or inter-tidal areas, the BLM will work with the USFWS to schedule the training at a time that is not a sensitive nesting/brood-rearing period or require that nest surveys be conducted in the training area prior to the rendering a decision on approving the training. The protocol and timing of nest surveys for Steller's and/or spectacled eiders will be determined in cooperation with the USFWS, and must be approved by the USFWS. Surveys should be supervised by biologists who have previous experience with Steller's and/or spectacled eider nest surveys.

E-19 Best Management Practice

Objective: Provide information to be used in monitoring and assessing wildlife movements during and after construction.

Requirement/Standard: A representation, in the form of ArcGIS-compatible shape-files, of all new infrastructure construction shall be provided to the authorized officer. During the planning and permitting phase, shape-files representing proposed locations shall be provided. Within 6 months of construction completion, shape-files (within GPS accuracy) of all new infrastructure shall be provided. Infrastructure includes all gravel roads and pads, facilities built on pads, pipelines and independently constructed powerlines (as opposed to those incorporated in pipeline design). Gravel pads shall be included as polygon feature. Roads, pipelines, and powerlines may be represented as line features but must include ancillary data to denote width, number pipes, etc. Poles for power lines may be represented as point features. Ancillary data shall include construction beginning and ending dates.

Use of Aircraft for Permitted Activities

F-1 Best Management Practice

Objective: Minimize the effects of low-flying aircraft on wildlife, subsistence activities, and local communities.

Requirement/Standard: The lessee shall ensure that aircraft used for permitted activities maintain altitudes according to the following guidelines (Note: This best management practice is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objectives of the stipulations and best management practices. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.):

a. Aircraft shall maintain an altitude of at least 1,500 feet above ground level when within ½ mile of cliffs identified as raptor nesting sites from April 15 through August 15 and an altitude of at least 1,500 feet above ground level when within ½ mile of known gyrfalcon nest sites from March 15 to August 15, unless doing so would endanger human life or violate safe flying practices. Permittees shall obtain information from the BLM necessary to plan flight routes when routes may go near falcon nests.
b. Aircraft shall maintain an altitude of at least 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1, unless doing so would endanger human life or violate safe flying practices. Caribou wintering areas will be defined annually by the authorized officer. The BLM will consult directly with the Alaska Department of Fish and Game in annually defining caribou winter ranges.
c. Land user shall submit an aircraft use plan as part of an oil and gas exploration or development proposal. The plan shall address strategies to minimize impacts to subsistence hunting and associated activities, including but not limited to the number of flights, type of aircraft, and flight altitudes and routes, and shall also include a plan to monitor flights. Proposed aircraft use plans should be reviewed by appropriate federal, State, and borough agencies. Consultations with these same agencies will be required if unacceptable disturbance is identified by subsistence users. Adjustments, including possible suspension of all flights, may be required by the authorized officer if resulting disturbance is determined to be unacceptable. The number of takeoffs and landings to support oil and gas operations with necessary materials and supplies should be limited to the maximum extent possible. During the design of proposed oil and gas facilities, larger landing strips and storage areas should be considered to allow larger aircraft to be employed, resulting in fewer flights to the facility.
d. Use of aircraft, especially rotary wing aircraft, near known subsistence camps and cabins or during sensitive subsistence hunting periods (spring goose hunting and fall caribou and moose hunting) should be kept to a minimum.
e. Aircraft used for permitted activities shall maintain an altitude of at least 2,000 feet above ground level (except for takeoffs and landings) over the Teshekpuk Lake Caribou Habitat Area (Map 2) from May 20 through August 20, unless doing so would endanger human life or violate safe flying practices. Aircraft use (including fixed wing and

helicopter) by oil and gas lessees in the Goose Molting Area (Map 2) should be minimized from May 20 through August 20, unless doing so would endanger human life or violate safe flying practices.

f. Aircraft used for permitted activities shall maintain an altitude of at least 2,000 feet above ground level (except for takeoffs and landings) over the Utukok River Uplands Special Area (Map 2) from May 20 through August 20, unless doing so would endanger human life or violate safe flying practices.

g. Hazing of wildlife by aircraft is prohibited. Pursuit of running wildlife is hazing. If wildlife begins to run as an aircraft approaches, the aircraft is too close and must break away.

h. Fixed wing aircraft used as part of a BLM-authorized activity along the coast shall maintain minimum altitude of 2,000 feet when within a ½-mile of walrus haulouts, unless doing so would endanger human life or violate safe flying practices. Helicopters used as part of a BLM-authorized activity along the coast shall maintain minimum altitude of 3,000 feet and a 1-mile buffer from walrus haulouts, unless doing so would endanger human life or violate safe flying practices.

i. Aircraft used as part of a BLM-authorized activity along the coast and shore fast ice zone shall maintain minimum altitude of 3,000 feet when within 1 mile from aggregations of seals, unless doing so would endanger human life or violate safe flying practices.

Oil Field Abandonment

G-1 Lease Stipulation

Objective: Ensure long-term reclamation of land to its previous condition and use.

Requirement/Standard: Prior to final abandonment, land used for oil and gas infrastructure—including but not limited to well pads, production facilities, access roads, and airstrips—shall be reclaimed to ensure eventual restoration of ecosystem function. The leaseholder shall develop and implement an abandonment and reclamation plan approved by the BLM. The plan shall describe short-term stability, visual, hydrological, and productivity objectives and steps to be taken to ensure eventual ecosystem restoration to the land's previous hydrological, vegetative, and habitat condition. The BLM may grant exceptions to satisfy stated environmental or public purposes.

Subsistence Consultation for Permitted Activities

H-1 Best Management Practice

Objective: Provide opportunities for participation in planning and decision making to prevent unreasonable conflicts between subsistence uses and other activities.

Requirement/Standard: Lessee/permittee shall consult directly with affected communities using the following guidelines:

a. Before submitting an application to the BLM, the applicant shall consult with directly affected subsistence communities, the North Slope Borough, and the National Petroleum Reserve-Alaska Subsistence Advisory Panel to discuss the siting, timing, and methods of their proposed operations to help discover local traditional and scientific knowledge, resulting in measures that minimize impacts to subsistence uses. Through this consultation, the applicant shall make every reasonable effort, including such mechanisms as conflict avoidance agreements and mitigating measures, to ensure that proposed activities will not result in unreasonable interference with subsistence activities. In the event that no agreement is reached between the parties, the authorized officer shall consult with the directly involved parties and determine which activities will occur, including the timeframes.
b. The applicant shall submit documentation of consultation efforts as part of its operations plan. Applicants should submit the proposed plan of operations to the National Petroleum Reserve-Alaska Subsistence Advisory Panel for review and comment. The applicant must allow time for the BLM to conduct formal government-to-government consultation with Native Tribal governments if the proposed action requires it.
c. A plan shall be developed that shows how the activity, in combination with other activities in the area, will be scheduled and located to prevent unreasonable conflicts with subsistence activities. The plan will also describe the methods used to monitor the effects of the activity on subsistence use. The plan shall be submitted to the BLM as part of the plan of operations. The plan should address the following items:
    1. A detailed description of the activity(ies) to take place (including the use of aircraft).
    2. A description of how the lessee/permittee will minimize and/or deal with any potential impacts identified by the authorized officer during the consultation process.

3. A detailed description of the monitoring effort to take place, including process, procedures, personnel involved and points of contact both at the work site and in the local community.
4. Communication elements to provide information on how the applicant will keep potentially affected individuals and communities up-to-date on the progress of the activities and locations of possible, short-term conflicts (if any) with subsistence activities. Communication methods could include holding community meetings, open house meetings, workshops, newsletters, radio and television announcements, etc.
5. Procedures necessary to facilitate access by subsistence users to the permitees' area of activity or facilities during the course of conducting subsistence activities.

d. During development, monitoring plans must be established for new permanent facilities, including pipelines, to assess an appropriate range of potential effects on resources and subsistence as determined on a case-by-case basis given the nature and location of the facilities. The scope, intensity, and duration of such plans will be established in consultation with the authorized officer and NPR-A Subsistence Advisory Panel.
e. Permittees that propose barging facilities, equipment, supplies, or other materials to NPR-A in support of oil and gas activities in the NPR-A shall notify, confer, and coordinate with the Alaska Eskimo Whaling Commission, the appropriate local community whaling captains' associations, and the North Slope Borough to minimize impacts from the proposed barging on subsistence whaling activities.
f. Barge operators requiring a BLM permit are required to demonstrate that barging activities will not have unmitigable adverse impacts on the availability of marine mammals to subsistence hunters.
g. All vessels over 50 ft. in length engaged in operations requiring a BLM permit must have an Automatic Identification System (AIS) transponder system on the vessel.

H-2 Best Management Practice

Objective: Prevent unreasonable conflicts between subsistence activities and geophysical (seismic) exploration.

Requirement/Standard: In addition to the consultation process described in Best Management Practice H-1 for permitted activities, before activity to conduct geophysical (seismic) exploration commences, applicants shall notify the local search and rescue organizations of proposed seismic survey

locations for that operational season. For the purpose of this standard, a potentially affected cabin/campsite is defined as any camp or campsite used for subsistence purposes and located within the boundary of the area subject to proposed geophysical exploration and/or within 1 mile of actual or planned travel routes used to supply the seismic operations while it is in operation.

a. Because of the large land area covered by typical geophysical operations and the potential to impact a large number of subsistence users during the exploration season, the permittee/operator will notify all potentially affected subsistence-use cabin and campsite users.
b. The official recognized list of subsistence-use cabin and campsite users is the North Slope Borough's most current inventory of cabins and campsites, which have been identified by the subsistence users' names.
c. A copy of the notification, a map of the proposed exploration area, and the list of potentially affected users shall also be provided to the office of the appropriate Native Tribal government.
d. The authorized officer will prohibit seismic work within 1 mile of any known subsistence-use cabin or campsite unless an alternate agreement between the cabin/campsite owner/user is reached through the consultation process and presented to the authorized officer. (Regardless of the consultation outcome, the authorized officer will prohibit seismic work within 300 feet of a known subsistence-use cabin or campsite.)
e. The permittee shall notify the appropriate local search and rescue (e.g., Nuiqsut Search and Rescue, Atqasuk Search and Rescue) of their current operational location within the NPR-A on a weekly basis. This notification should include a map indicating the current extent of surface use and occupation, as well as areas previously used/occupied during the course of the operation in progress. The purpose of this notification is to allow hunters up-to-date information regarding where seismic exploration is occurring, and has occurred, so that they can plan their hunting trips and access routes accordingly. Identification of the appropriate search and rescue offices to be contacted can be obtained from the coordinator of the NPR-A Subsistence Advisory Panel in the BLM's Arctic Field Office.

H-3 Best Management Practice

Objective: Minimize impacts to sport hunting and trapping species and to subsistence harvest of those animals.

Requirement/Standard: Hunting and trapping by lessee's/permittee's employees, agents, and contractors are prohibited when persons are on "work status." Work status is defined as the period during which an individual is under the control and supervision of an employer. Work status is terminated when the individual's shift ends and he/she returns to a public airport or community (e.g., Fairbanks, Barrow, Nuiqsut, or Deadhorse). Use of lessee/permittee facilities, equipment, or transport for personal access or aid in hunting and trapping is prohibited.

Orientation Programs Associated with Permitted Activities

I-1 Best Management Practice

Objective: Minimize cultural and resource conflicts.

Requirement/Standard: All personnel involved in oil and gas and related activities shall be provided information concerning applicable stipulations, best management practices, standards, and specific types of environmental, social, traditional, and cultural concerns that relate to the region. The lessee/permittee shall ensure that all personnel involved in permitted activities shall attend an orientation program at least once a year. The proposed orientation program shall be submitted to the authorized officer for review and approval and should:

a. provide sufficient detail to notify personnel of applicable stipulations and best management practices as well as inform individuals working on the project of specific types of environmental, social, traditional and cultural concerns that relate to the region.
b. Address the importance of not disturbing archaeological and biological resources and habitats, including endangered species, fisheries, bird colonies, and marine mammals, and provide guidance on how to avoid disturbance.
c. Include guidance on the preparation, production, and distribution of information cards on endangered and/or threatened species.
d. Be designed to increase sensitivity and understanding of personnel to community values, customs, and lifestyles in areas in which personnel will be operating.
e. Include information concerning avoidance of conflicts with subsistence, commercial fishing activities, and pertinent mitigation.

f. Include information for aircraft personnel concerning subsistence activities and areas/seasons that are particularly sensitive to disturbance by low-flying aircraft. Of special concern is aircraft use near traditional subsistence cabins and campsites, flights during spring goose hunting and fall caribou and moose hunting seasons, and flights near North Slope communities.
g. Provide that individual training is transferable from one facility to another except for elements of the training specific to a particular site.
h. Include on-site records of all personnel who attend the program for so long as the site is active, though not to exceed the 5 most recent years of operations. This record shall include the name and dates(s) of attendance of each attendee.
i. Include a module discussing bear interaction plans to minimize conflicts between bears and humans.
j. Provide a copy of 43 CFR 3163 regarding Non-Compliance Assessment and Penalties to on-site personnel.
k. Include training designed to ensure strict compliance with local and corporate drug and alcohol policies. This training should be offered to the North Slope Borough Health Department for review and comment.
l. Include training developed to train employees on how to prevent transmission of communicable diseases, including sexually transmitted diseases, to the local communities. This training should be offered to the North Slope Borough Health Department for review and comment.

Endangered Species Act—Section 7 Consultation Process

J. The lease areas may now or hereafter contain plants, animals, or their habitats determined to be threatened, endangered, or to have some other special status. The BLM may recommend modifications to exploration and development proposals to further its conservation and management objective to avoid BLM-approved activities that will contribute to the need to list such a species or their habitat. The BLM may require modifications to or disapprove a proposed activity that is likely to adversely affect a proposed or listed endangered species, threatened species, or critical habitat. The BLM will not approve any activity that may affect any such species or critical habitat until it completes its obligations under applicable requirements of the Endangered Species Act as amended, 16 USC § 1531 et seq., including completion of any required procedure for conference or consultation.

Additional Protections that Apply in Select Biologically Sensitive Areas

K-1 Lease Stipulation/Best Management Practice – Rivers

Note: This measure would be applied to relevant new leases. On lands unavailable for leasing in the respective alternatives, K-1 would be a best management practice. The decision indicated below in subparagraphs (a) and (d) modify Protection 1 of the Colville River Special Area Management Plan by widening its applicability to 2 miles.

Objective: Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of floodplain and riparian areas; the loss of spawning, rearing or over-wintering habitat for fish; the loss of cultural and paleontological resources; the loss of raptor habitat; impacts to subsistence cabin and campsites; the disruption of subsistence activities; and impacts to scenic and other resource values.

Requirement/Standard: Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited in the streambed and adjacent to the rivers listed below at the distances identified. (Gravel mines may be located within the active floodplain consistent with Best Management Practice E-8). On a case-by case basis, and in consultation with federal, State, and North Slope Borough regulatory and resource agencies (as appropriate, based on agency legal authority and jurisdictional responsibility), essential pipeline and road crossings to the main channel will be permitted through setback areas. The below setbacks may not be practical within river deltas; in such deltas, permanent facilities shall be designed to withstand a 200-year flood event. In the below list, if no upper limit for the setback is indicated, the setback extends to the head of the stream as identified in the National Hydrography Dataset.

a. **Colville River:** a 2-mile setback from the boundary of NPR-A where the river determines the boundary along the Colville River as determined by cadastral survey to be the highest high watermark on the left (western or northern) bank and from both banks' ordinary high watermark where BLM-manages both sides of the river up through T5S, R30W, U.M. Above that point to its source at the juncture of Thunder and Storm creeks the setback will be ½ mile. Note: The planning area excludes conveyed Native lands along the lower reaches of the Colville River. Development of road crossings intended to support oil and gas activities shall be consolidated with other similar projects and uses to the maximum extent possible. Note: This provision does not apply to intercommunity or other permanent roads

constructed with public funds for general transportation purposes, though the BLM would encourage minimal use of the setback area. This preserves the opportunity to plan, design, and construct public transportation systems to meet the economic, transportation, and public health and safety needs of the State of Alaska and/or communities within National Petroleum Reserve-Alaska.

b. **Ikpikpuk River**: a 2-mile setback from of the ordinary high watermark of the Ikpikpuk River extending from the mouth upstream through T7 N, R11W, U.M.; above that the setback would be for 1 mile to the confluence of the Kigalik River and Maybe Creek.

c. **Miguakiak River**: a ½-mile setback from the ordinary high watermark.

d. **Kikiakrorak and Kogosukruk Rivers**: A 2-mile setback from the top of the bluff (or ordinary high watermark if there is no bluff) on the Kikiakrorak River downstream from T2N., R4W, U.M. and on the Kogosukruk River (including Branch of Kogosukruk River, Henry Creek, and two unnamed tributaries off the southern bank) downstream from T2N, R3W, U.M. The setback from these streams in the named townships and further upstream as applicable will be a ½-mile from the top of the bluff or bank if there is no bluff.

e. **Fish Creek**: a 3-mile setback from the highest high watermark of the creek downstream from the eastern edge of section 31, T11N, R1E., U.M. and a ½-mile setback from the bank's highest high watermark farther upstream.

f. **Judy Creek**: a ½-mile setback from the ordinary high watermark.

g. **Ublutuoch (Tiŋmiaqsiugvik) River:** a ½-mile setback from the ordinary high water mark.

h. **Alaktak River**: a 1-mile setback from the ordinary high water mark.

i. **Chipp River**: a 1-mile setback from the ordinary high water mark.

j. **Oumalik River**: a ½-mile setback from the Oumalik River ordinary high water mark from the mouth upstream to section 5, T8N, R14W, U.M., and a ½ mile setback in and above section 5, T8N, R14W, U.M.

k. **Titaluk River**: a 2-mile setback from the ordinary high water mark from its confluence with the Ikpikpuk River upstream through T7N, R12W, U.M.; above that point the setback would be ½-mile from the ordinary high water mark.

l. **Kigalik River**: a ½-mile setback from the ordinary high water mark.

m. **Maybe Creek**: a ½-mile setback from the ordinary high water mark.

n. **Topagoruk River**: a 1-mile setback from the ordinary high water mark.

o. **Ishuktak Creek**: a ½-mile setback from the ordinary high water mark.
p. **Meade River**: a 1-mile setback from the ordinary high water mark on BLM-managed lands.
q. **Usuktuk River**: a 1-mile setback from the ordinary high water mark on BLM-managed lands.
r. **Pikroka Creek**: a ½-mile setback from the ordinary high water mark.
s. **Nigisaktuvik River**: a 1-mile setback from the ordinary high water mark.
t. **Inaru River**: a 1-mile setback from the ordinary high water mark.
u. **Kucheak Creek**: a ½-mile setback from the ordinary high water mark.
v. **Avalik River**: a 1-mile setback from the ordinary high water mark.
w. **Niklavik Creek**: a ½-mile setback from the ordinary high water mark.
x. **Kugrua River**: a ½-mile setback from the ordinary high water mark.
y. **Kungok River**: a 1-mile setback from the ordinary high water mark on BLM-managed lands.
z. **Kolipsun Creek**: a ½-mile setback from the ordinary high water mark upstream through T13N, R28W, U.M.
aa. **Maguriak Creek**: a ½-mile setback from the ordinary high water mark upstream through T12N, R29W, U.M.
ab. **Mikigealiak River**: a ½-mile setback from the ordinary high water mark upstream through T12N, R30W, U.M.
ac. **Kuk River**: a 1-mile setback from the ordinary high water mark on BLM-managed lands.
ad. **Ketik River**: a 1-mile setback from the ordinary high water mark.
ae. **Kaolak River**: a 1-mile setback from the ordinary high water mark.
af. **Ivisaruk River**: a 1-mile setback from the ordinary high water mark.
ag. **Nokotlek River**: a ½-mile setback from the ordinary high water mark.
ah. **Ongorakvik River**: a ½-mile setback from the ordinary high water mark.
ai. **Tunalik River**: a ½-mile setback from the ordinary high water mark.
aj. **Avak River**: a ½-mile setback from the ordinary high water mark within the NPR-A.
ak. **Nigu River**: a ½-mile setback from the ordinary high water mark from the confluence with the Etivluk River upstream to the boundary of NPR-A
al. **Etivluk River**: a ½-mile setback from the ordinary high water mark.
am. **Ipnavik River**: a ½-mile setback from the ordinary high water mark.
an. **Kuna River**: a ½-mile setback from the ordinary high water mark.
ao. **Kiligwa River**: a ½-mile setback from the ordinary high water mark.

ap. **Nuka River**: a ½-mile setback from the ordinary high water mark.
aq. **Driftwood Creek**: a ½-mile setback from the ordinary high water mark.
ar. **Utukok River**: a 1-mile setback from the ordinary high water mark within the NPR-A.
as. **Awuna River**: a ½-mile setback from the ordinary high water mark.
at. **Carbon Creek**: a ½-mile setback from the ordinary high water mark.
au. **Kokolik River**: a 1-mile setback from the ordinary high water mark within the NPR-A.
av. **Keolok Creek:** a ½-mile setback from the ordinary high water mark.

The decisions in subparagraphs K-1(a) and K-1(d) modify Colville River Management Plan Protection 1 by widening the setback in that measure to 2 miles. Protection 1 thus is modified to the following:

Colville River Special Area Management Plan-Protection 1
Objective: Minimize the loss of arctic peregrine falcon nesting habitat in the Colville River Special Area.
Requirement/Standard: To minimize the direct loss of arctic peregrine falcon nesting habitat and to protect nest sites in the Colville River Special Area the following protective measures apply: Permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited in the stream bed and adjacent to the rivers listed below at the distances identified. On a case-by-case basis, and in consultation with federal, State, and North Slope Borough regulatory and resource agencies (as appropriate; based on agency legal authority and jurisdictional responsibility), essential pipeline and road crossings perpendicular to the main channel will be permitted through setback areas.

a. Colville River: downstream of the Etivluk River a continuous 2-mile setback measured from the highest high watermark on the left bank (facing downstream); upstream of the Etivluk River a 2-mile setback measured from the ordinary high watermark of the bank on both sides of the river. Development of road crossings intended to support oil and gas activities shall be consolidated with other similar projects and uses to the maximum extent possible. This provision does not apply to intercommunity or other permanent roads constructed with public funds for general transportation purposes.
b. Kikiakrorak River: downstream from T2N, R4W, U.M., a continuous 2-mile setback as measured from the top of the bluff (or bank if there is no bluff) of both sides of the river.

c. Kogosukruk River: downstream from T2N, R3W, U.M., a continuous 2-mile setback as measured from the top of the bluff (or bank if there is no bluff) of both sides of the river and several of its tributaries.

K-2 Lease Stipulation/Best Management Practice – Deep Water Lakes

Note: This measure would be applied to relevant new leases. On lands unavailable for leasing, K-2 would be a best management practice.

Objective: Minimize the disruption of natural flow patterns and changes to water quality; the disruption of natural functions resulting from the loss or change to vegetative and physical characteristics of deep water lakes; the loss of spawning, rearing or over wintering habitat for fish; the loss of cultural and paleontological resources; impacts to subsistence cabin and campsites; and the disruption of subsistence activities.

Requirement/Standard: Generally, permanent oil and gas facilities, including gravel pads, roads, airstrips, and pipelines, are prohibited on the lake or lakebed and within ¼ mile of the ordinary high water mark of any deep lake as determined to be in lake zone III (i.e., depth greater than 13 feet [4 meters]; Mellor 1985). On a case-by-case basis in consultation with federal, State and North Slope Borough regulatory and resource agencies (as appropriate based on agency legal authority and jurisdictional responsibility), essential pipeline(s), road crossings, and other permanent facilities may be considered through the permitting process in these areas where the lessee can demonstrate on a site-specific basis that impacts will be minimal.

K-3 Best Management Practice – Kogru River, Dease Inlet, Admiralty Bay, Elson Lagoon, Peard Bay, Wainwright Inlet/Kuk River, and Kasegaluk Lagoon, and their associated Islands

Note: None of the area is available for oil and gas leasing or exploratory drilling. Therefore, K-3 will apply as a best management practice.

Objective: Protect fish and wildlife habitat (including, but not limited to, that for waterfowl and shorebirds, caribou insect-relief, and marine mammals), preserve air and water quality, and minimize impacts to subsistence activities and historic travel routes on the major coastal waterbodies.

Requirement/Standard (Development): With the exception of linear features such as pipelines, no permanent oil and gas facilities are permitted on or under the water within ¾ mile seaward of the shoreline (as measured from mean high tide) of the major coastal waterbodies or the natural coastal islands (to the extent that the seaward subsurface is within NPR-A). Elsewhere, permanent facilities within the major coastal waterbodies will

only be permitted on or under the water if they can meet all the following criteria:

a. Design and construction of facilities shall minimize impacts to subsistence uses, travel corridors, seasonally concentrated fish and wildlife resources.
b. Daily operational activities, including use of support vehicles, watercraft, and aircraft traffic, alone or in combination with other past, present, and reasonably foreseeable activities, shall be conducted to minimize impacts to subsistence uses, travel corridors, and seasonally concentrated fish and wildlife resources.
c. The location of oil and gas facilities, including artificial islands, platforms, associated pipelines, ice or other roads, bridges or causeways, shall be sited and constructed so as to not pose a hazard to navigation by the public using traditional high-use subsistence-related travel routes into and through the major coastal waterbodies as identified by the North Slope Borough.
d. Demonstrated year-round oil spill response capability, including the capability of adequate response during periods of broken ice or open water, or the availability of alternative methods to prevent well blowouts during periods when adequate response capability cannot be demonstrated. Such alternative methods may include seasonal drilling restrictions, improvements in blowout prevention technology, equipment and/or changes in operational procedures, and "top-setting" of hydrocarbon-bearing zones.
e. Reasonable efforts will be made to avoid or minimize impacts related to oil spill response activities, including vessel, aircraft, and pedestrian traffic that add to impacts or further compound "direct spill" related impacts on area resources and subsistence uses.
f. Before conducting open water activities, the permittee shall consult with the Alaska Eskimo Whaling Commission and the North Slope Borough to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope.

K-4a Best Management Practice – Goose Molting Area

Note: Except for less than 10,000 acres east of the mouth of the Ikpikpuk River, new non-subsistence infrastructure would be prohibited in the goose molting area. None of the area is available for oil and gas leasing or exploratory drilling.

<u>Objective</u>: Minimize disturbance to molting geese and loss of goose molting habitat in and around lakes in the Goose Molting Area.

Requirement/Standard (General): Within the Goose Molting Area no permanent oil and gas facilities, except for pipelines, will be allowed within 1 mile of the shoreline of goose molting lakes. No waiver, exception, or modification will be considered. Prior to the permitting of a pipeline in the Goose Molting Area, a workshop will be convened to determine the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources. The workshop participants will include but will not be limited to federal, state, and North Slope Borough representatives. In addition, only "in field" roads will be authorized as part of oil and gas field development.

Requirement/Standard (Development): In the Goose Molting Area, the following standards will be followed for permitted activities:

a. Within the Goose Molting Area from June 15 through August 20, all off-pad activities and major construction activities using heavy equipment (e.g., sand/gravel extraction and transport, pipeline and pad construction, but not drilling from existing production pads) shall be suspended (see also Best Management Practice K-5(d)), unless approved by the authorized officer in consultation with the appropriate federal, State, and North Slope Borough regulatory and resource agencies. The intent of this requirement is to restrict activities that will disturb molting geese during the period when geese are present.
b. Water extraction from any lakes used by molting geese shall not alter hydrological conditions that could adversely affect identified goose-feeding habitat along lakeshore margins. Considerations will be given to seasonal use by operators (generally in winter) and geese (generally in summer), as well as recharge to lakes from the spring snowmelt.
c. Oil and gas activities will avoid altering (i.e., damage or disturbance of soils, vegetation, or surface hydrology) critical goose-feeding habitat types along lakeshore margins (grass/sedge/moss) and salt marsh habitats.
d. Permanent oil and gas facilities (including gravel roads, pads, and airstrips, but excluding pipelines) and material sites will be sited outside the identified buffers and restricted surface occupancy areas. Additional limits on development footprint apply
e. Between June 15 and August, 20 within the Goose Molting Area, oil and gas facilities shall incorporate features (e.g., temporary fences, siting/orientation) that screen/shield human activity from view of any Goose Molting Area lake, as identified by the authorized officer in

consultation with appropriate federal, State, and North Slope Borough regulatory and resource agencies.

f. Strategies to minimize ground traffic shall be implemented from June 15 through August 20. These strategies may include limiting trips, use of convoys, different vehicle types, etc. to the extent practicable. The permittee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation. The vehicle use plan shall also include a vehicle-use monitoring plan. Adjustments will be required by the authorized officer if resulting disturbance is determined to be unacceptable.

g. Within the Goose Molting Area aircraft use (including fixed wing and helicopter) shall be restricted from June 15 through August 20 unless doing so endangers human life or violates safe flying practices. Restrictions may include: (1) limiting flights to two round-trips/week, and (2) limiting flights to corridors established by the BLM after discussions with appropriate federal, State, and North Slope Borough regulatory and resource agencies. The permittee shall submit with the development proposal an aircraft use plan that considers these and other mitigation. The aircraft use plan shall also include an aircraft monitoring plan. Adjustments, including perhaps suspension of all aircraft use, will be required by the authorized officer if resulting disturbance is determined to be unacceptable. Note: This site-specific best management practice is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objective of the stipulations and best management practices. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.

h. Any permit for development issued under this IAP/EIS will include a requirement for the permittee to conduct monitoring studies necessary to adequately determine consequences of development and any need for change to mitigations. Monitoring studies will be site- and development-specific within a set of over-arching guidelines developed by the BLM after conferring with appropriate federal, State, North Slope Borough agencies. The study(ies) will include the construction period and will continue for a minimum of 3 years after construction has been completed and production has begun. The monitoring studies will be a continuation of evaluating the effectiveness of Best Management Practice K-4a's requirements in meeting the objective of K-4a and determine if any changes to the best management practice or any project specific mitigation(s) are

necessary. If changes are determined to be necessary, the BLM, with the permittee and/or their representative, will conduct an assessment of the feasibility of altering development operation (e.g., reduced human activity, visibility barriers, noise abatement). Any changes determined necessary will be implemented prior to authorization of any new construction.

K-4b Best Management Practice – Brant Survey Area

Objective: Minimize the loss or alteration of habitat for, or disturbance of, nesting and brood rearing brant in the Brant Survey Area. None of the area is available for oil and gas leasing or exploratory drilling.

Requirement/Standard:

a. Aerial surveys for brant nesting colonies and brood-rearing areas shall be conducted for a minimum of 2 years before authorization of construction of permanent facilities. At a minimum, the survey area shall include the proposed development site(s) (i.e., the footprint) and the surrounding ½-mile area. These surveys shall be conducted following accepted BLM protocol.
b. Development may be prohibited or activities curtailed within ½-mile of all identified brant nesting colonies and brood-rearing areas identified during the 2-year survey

K-5 Best Management Practice –Teshekpuk Lake Caribou Habitat Area

Note: None of the area is available for oil and gas leasing or exploratory drilling. Therefore, K-5 will apply as a best management practice. Portions of K-5 that apply to permanent infrastructure are only relevant to the portion of the Teshekpuk Lake Caribou Habitat Area available to application for such infrastructure, i.e., to those areas outside of the approximately 1.1 million acres near the lake where no new non-subsistence permanent infrastructure will be permitted.

Objective: Minimize disturbance and hindrance of caribou, or alteration of caribou movements through portions the Teshekpuk Lake Caribou Habitat Area that are essential for all season use, including calving and rearing, insect-relief, and migration.

Requirement/Standard: In the Teshekpuk Lake Caribou Habitat Area the following standards will be applied to permitted activities:

a. Before authorization of construction of permanent facilities (limited as they may be by surface occupancy restrictions established in this decision), the permittee shall design and implement and report a study of caribou movement unless an acceptable study(s) specific to the

Teshekpuk Caribou Herd has been completed within the last 10 years. The study shall include a minimum of four years of current data on the Teshekpuk Caribou Herd movements and the study design shall be approved by the authorized officer in consultation with the appropriate federal, State, and North Slope Borough wildlife and resource agencies. The study should provide information necessary to determine facility (including pipeline) design and location. Permittee may submit individual study proposals or they may combine with other permittees in the area to do a single, joint study for the entire Teshekpuk Lake Caribou Habitat Area. Study data may be gathered concurrently with other activities as approved by the authorized officer and in consultation with the appropriate federal, State, and North Slope Borough wildlife and resource agencies. A final report of the study results will be prepared and submitted. Prior to the permitting of a pipeline in the Teshekpuk Lake Caribou Habitat Area, a workshop will be convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife (specifically the Teshekpuk Caribou Herd) and subsistence resources. The workshop participants will include but will not be limited to federal, State, and North Slope Borough representatives. All of these modifications will increase protection for caribou and other wildlife that utilize the Teshekpuk Lake Caribou Habitat Area during all seasons.

b. Within the Teshekpuk Lake Caribou Habitat Area, permittee shall orient linear corridors when laying out oil and gas field developments to address migration and corralling effects and to avoid loops of road and/or pipeline that connect facilities.
c. Ramps over pipelines, buried pipelines, or pipelines buried under the road may be required by the authorized officer, after consultation with appropriate federal, State, and North Slope Borough regulatory and resource agencies, in the Teshekpuk Lake Caribou Habitat Area where pipelines potentially impede caribou movement.
d. Major construction activities using heavy equipment (e.g., sand/gravel extraction and transport, pipeline and pad construction, but not drilling from existing production pads) shall be suspended within Teshekpuk Lake Caribou Habitat Area from May 20 through August 20, unless approved by the authorized officer in consultation with the appropriate federal, State, and North Slope Borough regulatory and resource agencies. The intent of this requirement is to restrict activities that will disturb caribou during calving and insect-relief

periods. If caribou arrive on the calving grounds prior to May 20, major construction activities will be suspended. The permittee shall submit with the development proposal a "stop work" plan that considers this and any other mitigation related to caribou early arrival. The intent of this latter requirement is to provide flexibility to adapt to changing climate conditions that may occur during the life of fields in the region.

e. The following ground and air traffic restrictions shall apply in the areas and time periods indicated. Ground traffic restrictions apply to permanent oil and gas-related roads:
    1. Within the Teshekpuk Lake Caribou Habitat Area, from May 20 through August 20, traffic speed shall not exceed 15 miles per hour when caribou are within ½ mile of the road. Additional strategies may include limiting trips, using convoys, using different vehicle types, etc., to the extent practicable. The permittee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation. The vehicle use plan shall also include a vehicle-use monitoring plan. Adjustments will be required by the authorized officer if resulting disturbance is determined to be unacceptable.
    2. The permittee or a contractor shall observe caribou movement from May 20 through August 20, or earlier if caribou are present prior to May 20. Based on these observations, traffic will be stopped:
        a. temporarily to allow a crossing by 10 or more caribou. Sections of road will be evacuated whenever an attempted crossing by a large number of caribou appears to be imminent. The permittee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation.
        b. by direction of the authorized officer throughout a defined area for up to four weeks to prevent displacement of calving caribou.

    The vehicle use plan shall also include a vehicle-use monitoring plan. Adjustments will be required by the authorized officer if resulting disturbance is determined to be unacceptable.
    3. Major equipment, materials, and supplies to be used at oil and gas work sites in the Teshekpuk Lake Caribou Habitat Area shall be stockpiled prior to or after the period of May 20 through August 20 to minimize road traffic during that period.
    4. Within the Teshekpuk Lake Caribou Habitat Area aircraft use (including fixed wing and helicopter) shall be restricted from May

20 through August 20 unless doing so endangers human life or violates safe flying practices. Authorized users of the NPR-A may be restricted from using aircraft larger than a Twin Otter, and limited to an average of one fixed-wing aircraft takeoff and landing per day per airstrip, except for emergency purposes. Restrictions may include prohibiting the use of aircraft larger than a Twin Otter by authorized users of the NPR-A, including oil and gas permittee, from May 20 through August 20 within the Teshekpuk Lake Caribou Habitat Area, except for emergency purposes. The permittee shall submit with the development proposal an aircraft use plan that considers these and other mitigation. The aircraft use plan shall also include an aircraft monitoring plan. Adjustments, including perhaps suspension of all aircraft use, will be required by the authorized officer if resulting disturbance is determined to be unacceptable. This best management practice is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objective of the stipulations and best management practices. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.

5. Aircraft shall maintain a minimum height of 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1, and 2,000 feet above ground level over the Teshekpuk Lake Caribou Habitat Area from May 20 through August 20, unless doing so endangers human life or violates safe flying practices. Caribou wintering ranges will be defined annually by the authorized officer in consultation with the Alaska Department of Fish and Game. This best management practice is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objective of the stipulations and best management practices. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.

K-6 Lease Stipulation/Best Management Practice – Coastal Area
Note: This measure would be applied to relevant new leases. On lands unavailable for leasing in the respective alternatives, K-6 would be a best management practice.
<u>Objective</u>: Protect coastal waters and their value as fish and wildlife habitat (including, but not limited to, that for waterfowl, shorebirds, and marine

mammals), minimize hindrance or alteration of caribou movement within caribou coastal insect-relief areas; protect the summer and winter shoreline habitat for polar bears, and the summer shoreline habitat for walrus and seals; prevent loss of important bird habitat and alteration or disturbance of shoreline marshes; and prevent impacts to subsistence resources and activities.

Requirement/Standard:

a. Exploratory well drill pads, production well drill pads, or a central processing facility for oil or gas would not be allowed in coastal waters or on islands between the northern boundary of the Reserve and the mainland, or in inland areas within one mile of the coast. (Note: This would include the entirety of the Kasegaluk Lagoon and Peard Bay Special Areas.) Other facilities necessary for oil and gas production within NPR-A that necessarily must be within this area (e.g., barge landing, seawater treatment plant, or spill response staging and storage areas) would not be precluded. Nor would this stipulation preclude infrastructure associated with offshore oil and gas exploration and production or construction, renovation, or replacement of facilities on existing gravel sites. Lessees/permittees shall consider the practicality of locating facilities that necessarily must be within this area at previously occupied sites such as various Husky/USGS drill sites and Distant Early Warning-Line sites. All lessees/permittees involved in activities in the immediate area must coordinate use of these new or existing sites with all other prospective users. Before conducting open water activities, the lessee shall consult with the Alaska Eskimo Whaling Commission, the North Slope Borough, and local whaling captains associations to minimize impacts to the fall and spring subsistence whaling activities of the communities of the North Slope. In a case in which the BLM authorizes a permanent oil and gas facility within the Coastal Area, the lessee/permittee shall develop and implement a monitoring plan to assess the effects of the facility and its use on coastal habitat and use.
b. Marine vessels used as part of a BLM-authorized activity shall maintain a 1-mile buffer from the shore when transiting past an aggregation of seals (primarily spotted seals) using a terrestrial haulout unless doing so would endanger human life or violate safe boating practices. Marine vessels shall not conduct ballast transfers or discharge any matter into the marine environment within 3 miles of the coast except when necessary for the safe operation of the vessel.

c. Marine vessels used as part of a BLM-authorized activity shall maintain a ½-mile buffer from shore when transiting past an aggregation of walrus using a terrestrial haulout.

K-7 Lease Stipulation/Best Management Practice - Colville River Special Area

Note: This measure would be applied to relevant new leases. On lands unavailable for leasing, K-7 would be a best management practice.

Objective: Prevent or minimize loss of raptor foraging habitat (also see Lease Stipulation K-1).

Requirement/Standard: If necessary to construct permanent facilities within the Colville River Special Area, all reasonable and practicable efforts shall be made to locate permanent facilities as far from raptor nests as feasible. Additionally, within 15 miles of raptor nest sites, significant alteration of high quality foraging habitat shall be prohibited unless the lessee can demonstrate on a site-specific basis that impacts would be minimal. Of particular concern are ponds, lakes, wetlands, and riparian habitats. Note: On a case-by-case basis, and in consultation with appropriate federal and State regulatory and resource agencies, essential pipeline and road crossings will be permitted through the Colville River Special Area where no other feasible or prudent options are available.

K-8 Best Management Practice - Pik Dunes

Note: None of the area is available for oil and gas leasing or exploratory drilling. Therefore, K-8 will apply as a best management practice.

Objective: Retain unique qualities of the Pik Dunes, including geologic and scenic uniqueness, insect-relief habitat for caribou, and habitat for several uncommon plant species.

Requirement/Standard: Surface structures, except approximately perpendicular pipeline crossings and ice pads, are prohibited within the Pik Dunes.

K-9 Best Management Practice – Teshekpuk Lake Caribou Movement Corridor

Note: None of the area is available for oil and gas leasing or exploratory drilling. Therefore, K-9 will apply as a best management practice. All of the former movement corridor northwest of Teshekpuk Lake and all but the eastern-most part of the other corridor that lies north of the Kogru River are within an area prohibiting new non-subsistence infrastructure. Therefore,

this best management practice only applies to the lands in the former corridor north of the Kogru River in Ts. 14-15 N., R. 2 W., U.M.
Objective: Minimize disturbance and hindrance of caribou, or alteration of caribou movements (that are essential for all season use, including calving and rearing, insect-relief, and migration) in the area extending from the eastern shore of Teshekpuk Lake eastward to the Kogru River.
Requirement/Standard: Within the Teshekpuk Lake Caribou Movement Corridor, no permanent oil and gas facilities, except for pipelines or other infrastructure associated with offshore oil and gas exploration and production, will be allowed. Prior to the permitting of permanent oil and gas infrastructure in the Caribou Movement Corridor, a workshop will be convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources. The workshop participants will include but will not be limited to federal, State, and North Slope Borough representatives.

K-10 Best Management Practice – Southern Caribou Calving Area
Note: None of the area is available for oil and gas leasing or exploratory drilling. Therefore, K-10 will apply as a best management practice. All but the eastern-most part of the former Southern Caribou Calving Area lies within an area prohibiting new non-subsistence infrastructure. Therefore, this best management practice only applies to the lands in the former area T. 14 N., Rs. 1-2 W., U.M.; T. 14 N., R. 1 E., U.M; and T. 15 N., R. 2 W., U.M.
Objective: Minimize disturbance and hindrance of caribou, or alteration of caribou movements (that are essential for all season use, including calving and post calving, and insect-relief) in the area south/southeast of Teshekpuk Lake.
Requirement/Standard: Within the Southern Caribou Calving Area, no permanent oil and gas facilities, except pipelines or other infrastructure associated with offshore oil and gas exploration and production, will be allowed. Prior to the permitting of permanent oil and gas infrastructure in the Southern Caribou Calving Area, a workshop will be convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife and subsistence resources. The workshop participants will include but will not be limited to federal, State, and North Slope Borough representatives.

K-11 Lease Stipulation/Best Management Practice – Western Arctic Herd Habitat Area

Note: This measure would be applied to relevant new leases. On lands unavailable for leasing, K-11 would be a best management practice. Portions of K-11 that apply to permanent infrastructure are only relevant to the northern portion of the Utukok River Uplands Special Area available to application for such infrastructure.

Objective: Minimize disturbance and hindrance of caribou, or alteration of caribou movements through the Utukok River Uplands Special Area that are essential for all season use, including calving and rearing, insect-relief, and migration.

Requirement/Standard: In the Utukok River Uplands Special Area the following standards will be applied to permitted activities:

a. Before authorization of construction of permanent facilities, the lessee shall design and implement and report a study of caribou movement unless an acceptable study(s) specific to the Western Arctic Herd has been completed within the last 10 years. The study shall include a minimum of four years of current data on the Western Arctic Herd's movements and the study design shall be approved by the authorized officer in consultation with the appropriate federal, State, and North Slope Borough wildlife and resource agencies and the Western Arctic Caribou Herd Working Group. The study should provide information necessary to determine facility (including pipeline) design and location. Lessees may submit individual study proposals or they may combine with other lessees in the area to do a single, joint study for the entire Utukok River Uplands Special Area. Study data may be gathered concurrently with other activities as approved by the authorized officer and in consultation with the appropriate federal, State, and North Slope Borough wildlife and resource agencies. A final report of the study results will be prepared and submitted. Prior to the permitting of a pipeline in the Utukok River Uplands Special Area, a workshop will be convened to identify the best corridor for pipeline construction in efforts to minimize impacts to wildlife (specifically the Western Arctic Herd) and subsistence resources. The workshop participants will include but will not be limited to federal, State, and North Slope Borough representatives. All of these modifications will increase protection for caribou and other wildlife that utilize the Utukok River Uplands Special Area during all seasons.
b. Within the Utukok River Uplands Special Area, lessees shall orient linear corridors when laying out oil and gas field developments to

address migration and corralling effects and to avoid loops of road and/or pipeline that connect facilities.

c. Ramps over pipelines, buried pipelines, or pipelines buried under the road may be required by the authorized officer, after consultation with appropriate federal, State, and North Slope Borough regulatory and resource agencies, in the Utukok River Uplands Special Area where pipelines potentially impede caribou movement.
d. Major construction activities using heavy equipment (e.g., sand/gravel extraction and transport, pipeline and pad construction, but not drilling from existing production pads) shall be suspended within Utukok River Uplands Special Area from May 20 through August 20, unless approved by the authorized officer in consultation with the appropriate federal, State, and North Slope Borough regulatory and resource agencies. The intent of this requirement is to restrict activities that will disturb caribou during calving and insect-relief periods. If caribou arrive on the calving grounds prior to May 20, major construction activities will be suspended. The lessee shall submit with the development proposal a "stop work" plan that considers this and any other mitigation related to caribou early arrival. The intent of this latter requirement is to provide flexibility to adapt to changing climate conditions that may occur during the life of fields in the region.
e. The following ground and air traffic restrictions shall apply to permanent oil and gas-related roads in the areas and time periods indicated:
    1. Within the Utukok River Uplands Special Area, from May 20 through August 20, traffic speed shall not exceed 15 miles per hour when caribou are within ½ mile of the road. Additional strategies may include limiting trips, using convoys, using different vehicle types, etc., to the extent practicable. The lessee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation. The vehicle use plan shall also include a vehicle-use monitoring plan. Adjustments will be required by the authorized officer if resulting disturbance is determined to be unacceptable.
    2. The lessee or a contractor shall observe caribou movement from May 20 through August 20, or earlier if caribou are present prior to May 20. Based on these observations, traffic will be stopped:
        a. Temporarily to allow a crossing by 10 or more caribou. Sections of road will be evacuated whenever an attempted

crossing by a large number of caribou appears to be imminent. The lessee shall submit with the development proposal a vehicle use plan that considers these and any other mitigation.

b. By direction of the authorized officer throughout a defined area for up to four weeks to prevent displacement of calving caribou.

The vehicle use plan shall also include a vehicle-use monitoring plan. Adjustments will be required by the authorized officer if resulting disturbance is determined to be unacceptable.

3. Major equipment, materials, and supplies to be used at oil and gas work sites in the Utukok River Uplands Special Area shall be stockpiled prior to or after the period of May 20 through August 20 to minimize road traffic during that period.
4. Within the Utukok River Uplands Special Area aircraft use (including fixed wing and helicopter) shall be restricted from May 20 through August 20 unless doing so endangers human life or violates safe flying practices. Authorized users of the NPR-A may be restricted from using aircraft larger than a Twin Otter, and limited to an average of one fixed-wing aircraft takeoff and landing per day per airstrip, except for emergency purposes. Restrictions may include prohibiting the use of aircraft larger than a Twin Otter by authorized users of the NPR-A, including oil and gas lessees, from May 20 through August 20 within the Utukok River Uplands Special Area, except for emergency purposes. The lessee shall submit with the development proposal an aircraft use plan that considers these and other mitigation. The aircraft use plan shall also include an aircraft monitoring plan. Adjustments, including perhaps suspension of all aircraft use, will be required by the authorized officer if resulting disturbance is determined to be unacceptable. This lease stipulation is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objective of the stipulations and best management practices. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.
5. Aircraft shall maintain a minimum height of 1,000 feet above ground level (except for takeoffs and landings) over caribou winter ranges from December 1 through May 1, and 2,000 feet above ground level over the Utukok River Uplands Special Area from May 20 through August 20, unless doing so endangers human life or violates safe flying practices. Caribou wintering ranges will be

defined annually by the authorized officer in consultation with the Alaska Department of Fish and Game. This lease stipulation is not intended to restrict flights necessary to survey wildlife to gain information necessary to meet the stated objective of the stipulations and best management practices. However, flights necessary to gain this information will be restricted to the minimum necessary to collect such data.

Summer Vehicle Tundra Access

L-1 Best Management Practice

Objective: Protect stream banks and water quality; minimize compaction and displacement of soils; minimize the breakage, abrasion, compaction, or displacement of vegetation; protect cultural and paleontological resources; maintain populations of, and adequate habitat for birds, fish, and caribou and other terrestrial mammals; and minimize impacts to subsistence activities.

Requirement/Standard: On a case-by-case basis, BLM may permit low-ground-pressure vehicles to travel off of gravel pads and roads during times other than those identified in Best Management Practice C-2a. Permission for such use would only be granted after an applicant has:

a. Submitted studies satisfactory to the authorized officer of the impacts on soils and vegetation of the specific low-ground-pressure vehicles to be used. These studies should reflect use of such vehicles under conditions similar to those of the route proposed for use and should demonstrate that the proposed use would have no more than minimal impacts to soils and vegetation.
b. Submitted surveys satisfactory to the authorized officer of subsistence uses of the area as well as of the soils, vegetation, hydrology, wildlife and fish (and their habitats), paleontological and archaeological resources, and other resources as required by the authorized officer.
c. Designed and/or modified the use proposal to minimize impacts to the authorized officer's satisfaction. Design steps to achieve the objectives and based upon the studies and surveys may include, but not be limited to, timing restrictions (generally it is considered inadvisable to conduct tundra travel prior to August 1 to protect ground-nesting birds), shifting of work to winter, rerouting, and not proceeding when certain wildlife are present or subsistence activities are occurring. At the discretion of the authorized officer, the plan for summer tundra vehicle access may be included as part of the spill

prevention and response contingency plan required by 40 CFR 112 (Oil Pollution Act) and Best Management Practice A-4.

General Wildlife and Habitat Protection

M-1 Best Management Practice

Objective: Minimize disturbance and hindrance of wildlife, or alteration of wildlife movements through the NPR-A.
Requirement/Standard: Chasing wildlife with ground vehicles is prohibited. Particular attention will be given to avoid disturbing caribou.

M-2 Best Management Practice

Objective: Prevent the introduction, or spread, of non-native, invasive plant species in the NPR-A.
Requirement/Standard: Certify that all equipment and vehicles (intended for use either off or on roads) are weed-free prior to transporting them into the NPR-A. Monitor annually along roads for non-native invasive species, and initiate effective weed control measures upon evidence of their introduction. Prior to operations in the NPR-A, submit a plan for the BLM's approval, detailing the methods for cleaning equipment and vehicles, monitoring for weeds and weed control.

M-3 Best Management Practice

Objective: Minimize loss of populations of, and habitat for, plant species designated as Sensitive by the BLM in Alaska.
Requirement/Standard: If a development is proposed in an area that provides potential habitat for a BLM Sensitive Plant Species, the development proponent would conduct surveys at appropriate times of the summer season and in appropriate habitats for the Sensitive Plant Species that might occur there. The results of these surveys will be submitted to the BLM with the application for development.

M-4 Best Management Practice

Objective: Minimize loss of individuals of, and habitat for, mammalian species designated as Sensitive by the BLM in Alaska.
Requirement/Standard: If a development is proposed in an area that provides potential habitat for the Alaska tiny shrew, the development proponent would conduct surveys at appropriate times of the year and in appropriate

habitats in an effort to detect the presence of the shrew. The results of these surveys will be submitted to BLM with the application for development.

State of Alaska Statutes and Regulations Protecting Environmental Quality

<u>Alaska Statutes</u>

AS 46.03.100	Waste management and disposal authorization
AS 46.03.740	Oil pollution
AS 46.03.745	Hazardous substance release
AS 46.03.800	Water nuisances
AS 46.03.810	Air and land nuisances
AS 46.14.010	Emission control regulation

<u>Alaska Department of Environmental Quality Regulations</u>

Air Quality Control

18 AAC 50.030	State air quality control plan
18 AAC 50.045	Prohibitions
18 AAC 50.065	Open burning
18 AAC 50.110	Air pollution prohibited

Solid Waste Management

18 AAC 60.200	Permit requirement
18 AAC 60.230	Disease vector, wildlife and domestic animal control
18 AAC 60.233	Controlling impact outside facility boundaries

Wastewater Disposal

18 AAC 72.050	Minimum treatment
18 AAC 72.200	Application for department approval
18 AAC 72.215	Permit required – domestic wastewater
18 AAC 72.275	Disposal systems
18 AAC 72.500	Permit required – nondomestic wastewater

Oil and other Hazardous Substances Pollution Control

18 AAC 75.007	General oil pollution prevention requirements
18 AAC 75.045	Operating requirements for exploration and production facilities
18 AAC 75.047	Requirements for flowlines at production facilities
18 AAC 75.055	Leak detection, monitoring and operating requirements for crude oil transmission pipelines
18 AAC 75.075	Secondary containment requirements for aboveground storage tanks
18 AAC 75.080	Requirements for facility oil piping
18 AAC 75.300-396	Discharge reporting, cleanup and disposal of oil and other hazardous substances
18 AAC 75.400-496	Oil discharge prevention and contingency plans and nontank vessel plans
18 AAC 75.605-670	Civil penalties for discharge of petroleum and petroleum product and byproducts
18 AAC 75.700-730	Surface oiling

18 AAC 75.800-830 Oil discharge for scientific purposes

These statutes and regulations can be obtained from links here:
http://dec.alaska.gov/commish/regulations/index.htm

APPENDIX K

NORTH SLOPE AVIATION DISTURBANCE INFORMATION

Greater Mooses Tooth 2 Development Project

Draft Supplemental Environmental Impact Statement

Appendix K:

(Chapter 4 Section 4.5: Subsistence)

North Slope Aviation Disturbance Information

A-1: 2016 North Slope Borough Oil and Gas Forum Final Report[1]:
Summary of Breakout Session #6: Reducing Impacts from North Slope Air Traffic

Desired Outcome of Breakout Session: Provide an opportunity for North Slope residents to identify their concerns about air traffic and identify future cooperation among stakeholders to reduce impacts

Common Themes Identified by Session Participants:

- Increase communication (37 votes)
- Reduce frustration by using alternate transport modes and local hire (37 votes)
- Educate researchers, identify their impacts and mitigate (33 votes)
- Time and area closures - Conflict Avoidance Agreement (CAA) model (32 votes)
- Consolidate agency site inspections (14 votes)
- Social media – connecting locals (8 votes)
- Be good neighbors (5 votes)
- Best Practices (4 votes)

Specific Recommendations:

- Increase communication with local residents - use social media.
- Consider time and area closures (use CAA model).
- Reduce flights needed by deploying fuel and supplies by land during winter.
- Use camps for research and to decrease impacts.
- Remove areas from lease sales to reduce impacts.
- Use a "good neighbor" approach.
- Require permittees to identify where they will be landing and type of aircraft
- Hire locals, use subsistence advisors.
- Identify who researchers should contact.
- Coordinate agency inspections (e.g., combine flights to reduce aircraft).
- Tracking flights -Consolidate flight information among agencies.
- Minimize research projects and share information (BLM and EPA have done this).
- Identify what can be done to mitigate impacts before the fact.
- Agencies should communicate with villagers in the same way that industry does.
- Consider involving the North Slope Science Initiative to address this issue.
- Help government agencies learn from industry to help relationships with local people.
- Reduce "stick picking" to reduce impacts of aircraft.

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[1] The complete Final Report of the NSB 2016 Oil and Gas Forum is available online at: http://www.north-slope.org/assets/images/uploads/news/FinalOGforumReport.pdf

- Consider impacts from all aircraft (industry, agency, researchers, ecotourism, recreational
- users).
- Document history and lessons learned.
- Share information about subsistence times:
- Many hunting seasons on the North Slope; winter, breakup, etc.
- Share a subsistence calendar to identify what types of hunting are occurring when.
- Increase communication between researchers and residents:
- Inform researchers regarding all parties to contact – find ways to inform researchers as
- to how to communicate and mitigate impacts.
- Continue use of call centers
- Shell would call into call centers to find out where people were going
- Agencies should contribute to funding of call centers.
- Identify flight patterns - build on existing Audubon map.

Other Comments:

- Communication should be a two-way street. Residents, industry and other agencies willing to communicate, just need to make it happen.
- Frustration because of a lack of responsiveness from agencies.
- Delegation of authority is not clear – don't know who is responsible.
- Call centers:
    - What is the status of call centers? Shell funded them in the past, but not this year.
    - Funding agencies should help contribute to these call centers to help villages with
    - cultural needs and subsistence needs.
    - Conoco Phillips has a daily call number that people can call. Also have a daily recording to let people know what the activity is in the area (Nuiqsut only).
- Barrow search and rescue can be called but looking out for game.
- Planes do interfere with the subsistence lifestyle – villagers live off the food of the land and sea - villagers impacted by aircraft and by outside hunters coming in to their area.
- After impact has occurred it is too late and hunter does not get any game and loses money on the hunt. This has gone on for several years now. Still talking but not solved yet. These are real situations when a hunter can't provide food for family or community. People go without food as a result.
- Long history – lots of data, must sit down and put it all together. Agency communication and
- cooperation is needed. Permits are given to many different people and agencies which
- villagers don't know about. They are told it is "every day stuff." Tourism, sightseeing, sport
- fishing, etc. use aircraft. They can disrupt the wildlife actions and patterns. Take the local

- people's history in mind is important.
- Non-subsistence hunters have been a problem in Anaktuvuk Pass.
- Wainwright worked with industry to talk about impacts and mitigation, industry hired people and worked with the village dates. Agencies don't do this and are not as sensitive. Want industry to communicate with people but the agencies don't follow that example.
- Wainwright has cancelled at least one project due to the impacts of aircraft on people.
- Communication must go both ways.
- Alaska Eskimo Whaling Commission is a leader – Diomede was declared nutritionally a disaster
- area – no food, no resources for them.
- 10 Summary Report - North Slope Borough 2016 Oil and Gas Forum: Appendix E
- Government agencies are not sensitive to the local subsistence calendars.
- Lack of local hire increases the need for aircraft.
- Tracking:
  - Subsistence Advisory Panel Meetings identify impacts.
  - Permits (number of takeoffs and landings).
  - As a resident I don't know who is out there with aircraft.
- It is very expensive to travel.
- Air traffic over and around the walrus haul out at Point Lay creates a hazard to the walrus herd - stampeding occurs.

A-2 BLM NPR-A Subsistence Advisory Panel Recommendations on Aviation 2000 – 2016

Note: There are 178 recommendations in the most recent spreadsheet of SAP recommendations. Of those, the following 31 recommendations refer specifically to aviation. These recommendations account for over over 17 percent of the total.

There have been numerous SAP recommendations that refer to conflicts that likely meant aviation disturbance; they were not included.

1. #21 6/2000, Thomas Napageak Sr.: Concern: People have witnessed FWS (or another research entity) hovering over the herd, trying to turn them away from coming toward the village. I think it is not appropriate for Fish and Wildlife, or the oil companies, to hover over caribou. Fly high, or get out of there.

2. #23 9/2000, Paul Ogroogak: Also planes have been flying low, thinks it's the Helmericks, and Fish and Game should look at that.

3. #46 8/2001, SAP Panel: Conflicts between subsistence users and aircraft, especially helicopters.

4. #68 8/2002: Concern that there was a lot of helicopter activity in the Nuiqsut area during the summer.

5. #78 6/2003: Arnold Brower: Helicopter flights in the spring impacted goose hunter--recommended to the AO to have helicopters fly higher or lessen the number of flights.

6. #82 6/ 2003: Baxter Hopson: If the oil companies or contractors say they are going to have a set number of flights, then the BLM needs to make sure they stay within this self-imposed limit.

7. #109 12/2005, Dorothy Edwardsen: July and August are very important subsistence months, aircraft use (helicopter and fixed wing) should be kept to a minimum during this time, especially around communities

8. #111 3/2005, Taqulik Hepa: Recommendation that the different companies working in NPR-A hold a meeting to coordinate studies and helicopter use in order to reduce the impact of the studies.

9. #131 8/2007, SAP Panel: Recommendation that the BLM create two brochures to help alleviate impacts to subsistence from aircraft (primarily helicopter) use. The SAP characterized the problem as they saw it as: 1) occurrences when a helicopter directly interferes with a hunt (i.e., moving caribou or other game away from the hunter); 2) the belief that many pilots intentionally herd caribou using the helicopter, as this has been witnessed by residents on the Slope; 3) the concern that pilots don't know what the rules/stipulations are; and 4) the belief that many pilots do know what the rules are, but purposefully push the limits of the rules to see what they can get away with.

10. #135 12/2007, Nanuaq Thorpe: Recommended that the Flight Use brochures be distributed to all of the small aircraft companies and their pilots who fly on the North Slope.

11. #148 4/2009, Isaac Nukapigak: Recommended to BLM employees that something needs to be done about the interference to subsistence waterfowl hunters of helicopters during break-up. The helicopters are there to study hydrology and break-up, which coincides with waterfowl hunting for the community. Isaac recommended that all parties (researchers with the BLM, USGS, and contractors to CPAI) get together to talk about helicopter routes, frequency of visits and timing.

12. #154 12/2010, Andrew Hopson: The SAP should talk with the companies (and government agencies) developing the road to Umiat and try to stop the use of private aircraft (hunters) in that area.

13. #166 3/2012, Panel: SAP recommended that Alaska Fish and Game wildlife surveys coordinate their flights with Search and Rescue and the BLM encourage other permitted surveys to do the same.

14. #172 3/2012, Raymond Aguvluk: Aguvluk reported that because Wainwright has had so many concerns with helicopters that BLM and researchers should save money and disturb fewer hunters by using boats and other less disruptive travel methods.

15. #177 11/2012, Panel: Recommended that BLM arrange to have a representative of the FAA present at a SAP meeting to discuss whether there is any possibility of establishing special restrictions on flights over the NPR-A.

16. #178 11/2012, SAP Panel: Recommended that BLM establish a system that allows information on North Slope aviation (flight paths, tail numbers) to be shared among the public, cities, and tribal governments.

17. #210 2/2014, Joe Sage: Baseline information on the impacts of aircraft traffic on wildlife is needed to illustrate that the traffic is depriving the animals of the time they need to rest and feed in certain areas and aircraft traffic needs to be reduced.

18. #211 2/2014, Joe Sage and Sam Kunaknana: Researchers and others using aircraft should camp in one site, visit the sites they need to study around them by other means, and then fly to another site to eliminate take offs and landings.

19. #212 2/2014, Joe Sage and Bart Ahsogeak: Tribes, industry, and agencies need to work together to improve enforcement on aircraft restrictions.

20. #214 9/2014, Warren Lampe: Kuparuk River near Point Lay be added to the BLM's Aviation Awareness and Conflict Avoidance letter as a heavily used subsistence river that should be avoided by aircraft whenever possible.

21. #217 9/2014, Bart Ahsogeak: Language should be added to the Aviation Awareness and Conflict Avoidance letter instructing permittees and others involved with aviation on the North Slope to contact the city administration or the Tribe before flying in the area and to provide notification of when and where aircraft activity will occur

22. #220 9/2014, Qaiyaan Harcharek: Amendment to BMP F-1 (e): The measure currently requires that aircraft maintain an altitude of at least 2,000 feet over the Teshekpuk Lake Caribou Herd Area from May 20 through August 20. Harcharek suggested that BLM extend those dates from May 20 through October 20 to better protect the fall hunting season.

23. #221 9/2014, Qaiyaan Harcharek: BLM require aircraft information at the permit application stage (color, description, tail number).

24. #133 2/2015, Joe Sage: Industry and researchers share data whenever possible to save money and reduce aircraft traffic. Requests that everyone involved with activities on the North Slope listen carefully to all the concerns about aircraft disturbance and understand what a real and significant impacts it is on indigenous hunters.

25. #137 9/2015, Warren Lampe and Terry Tagarook: Lampe: Although studies have declined around Point Lay, recommends that all permitting agencies notify the community about all permits, especially those for in the area that will use aircraft. Tagarook: any entity giving permits out improve the process of notifying potentially affected communities

26. #143 9/2015, Colleen Akpik-Lemen: BLM increase its enforcement arm so that it is not left to the community members to argue with aircraft users and outside hunters.

27. #159 6/1/2016, Qaiyaan Harcharek: Requested that the soundscape ecology (aircraft noise monitoring) project be expanded to Anaktuvuk Pass and other villages and subsistence areas.

28. #161 6/1/2016, Bart Ahsogeak: Recommended that all studies scheduled to occur on the North Slope be delayed for two years in order to reduce the amount of helicopter traffic during caribou hunting season.

29. #165 6/1/2016, Sam Kunaknana: Recommended that State of Alaska freshwater fish inventory participants float down rivers instead of flying with helicopters.

30. #175 6/1/2016 Sam Kunaknana: Recommended that at the next meeting the BLM show total number of flights, including on the east (state) side, taken throughout the study season to better analyze cumulative impacts.

31. #176 6/1/2016, Qaiyaan Harcharek: Recommended that any studies where it is feasible should hire local boats for transportation rather than fly in helicopters.

A-3: ICAS Resolution on Aviation

IÑUPIAT COMMUNITY of the ARCTIC SLOPE

An IRA Regional Tribal Government

P.O Box 934 • Barrow, Alaska 99723
Ph: (907)852-4227 (888)788-4227 Fax: (907)852-4246

Resolution 2014- 12

RESOLUTION ADDRESSING THE INALIENABLE NATURE OF INUPIAT SUBSISTENCE/HARVEST RIGHTS WITHIN THE ARCTIC SLOPE

WHEREAS, The Inupiat Community of the Arctic Slope (ICAS) is a federally recognized Native tribe of Inupiat Eskimos under the Indian Reorganization Act of 1934, a Regional Tribal Government, as amended, whose governing body is the ICAS Executive Board with representatives from all eight Inupiat tribal councils in the Arctic Slope of Alaska; and

WHEREAS, ICAS Regional Tribal Council (a,k.a, ICAS Executive Board) is the governing body of ICAS and is responsible for protecting the interests of its tribal members and its rights of self - governance; and

WHEREAS ,A Resolution addressing the high air traffic low flying airplanes, helicopters, and aircraft that hinder and divert the migrating caribou herds away from our villages of Barrow , Atqasuk, Wainwright, Point Lay, Point Hope, Kaktovik, Nuiqsut, and Anaktuvuk Pass, during the summer months June through October, that usually come to our villages, for insect relief, and escapement from predators, and

WHEREAS, the tribe represent the interest of over 9,000 members residing in the Arctic Communities of Anaktuvuk Pass, Atqasuk, Barrow, Kaktovik, Nuiqsut, Point Hope, Point Lay, and Wainwright, and,

WHEREAS,ICAS was founded to promote the security, and social welfare of its members, to exercise its power of the Tribal self-government, and to advance, protect, and preserve its common interest as descendants of the aboriginal Inupiat people of the Arctic Slope region of Alaska, and,

WHEREAS, Inupiat subsistence hunting, fishing, trapping, whaling, and gathering rights must take preference over any non-subsistence use of wildlife resources in the Arctic Slope region, and no other nations shall not interfere with our subsistence hunting rights and

WHEREAS, to alleviate high air traffic low flying airplanes, helicopters, and aircraft that hinder and divert the migrating caribou herds away from our village, and

NOW THEREFORE BE IT RESOLVED, that the Inupiat Community of the Arctic Slope is seeking assistance from the Office of Subsistence Management, Federal Aviation Administration, Bureau of Land Management Subsistence Advisory Panel, North Slope Borough Wildlife Department, North Slope Borough Game Management Board, BLM Subsistence Advisory Board, Federal Subsistence Advisory Panel, Bureau of Land Management Advisory Panel, Alaska National Meritime Wildlife Refuge , Gates of the Arctic National Park Service, U.S. Department of Office of Interior Fish & Wildlife Service, and Department of Interior to alleviate the high air traffic low flying aircraft, airplanes, and helicopter use from diverting the caribou migrations to our villages, and

BE IT FURTHER RESOLVED, that the Inupiat Community of the Arctic Slope has adopted and passed this resolution at the Inupiat Community of the Arctic Slope Annual meeting on August 23, 2014, in Barrow, Alaska.

George Olemaun , ICAS President

Doreen Ahgeak , ICAS Secretary

APPENDIX L

ANILCA 810 SUBSISTENCE ANALYSIS

APPENDIX L: ANILCA § 810 ANALYSIS OF SUBSISTENCE IMPACTS

This analysis of subsistence impacts is for the proposed Greater Mooses Tooth Unit 2 (GMT 2) Development Project Supplemental Environmental Impact Statement (SEIS). The GMT2 SEIS supplements the 2004 Alpine Satellite Development Plan (ASDP) EIS. ConocoPhillips Alaska, Inc. (ConocoPhillips) submitted an application to the Bureau of Land Management (BLM) for a permit to drill and related authorizations in August 2015. The proposed GMT2 site is located on Alaska's North Slope in the northeast corner of the National Petroleum Reserve in Alaska (NPR-A), immediately west of the Colville River Delta and approximately 16.5 miles west of the town of Nuiqsut.

The proposed GMT2 drill site is located on BLM-managed lands selected by the Kuukpik Corporation, the Alaska Native Claims Settlement Act (ANCSA) village corporation for the community of Nuiqsut. Two of the four alternatives analyzed in the GMT2 SEIS include an access road to the GMT2 drill site from the GMT1 pad. Each action alternative includes a pipeline connecting GMT2 and GMT1.

The GMT2 site is one of five drill sites that were included in the 2004 ASDP EIS. The BLM issued a Record of Decision (ROD) in 2004 that approved the Preferred Alternative for permitting. In the ASDP EIS, the GMT1 and GMT2 sites were referred to as CD6 and CD7 respectively. After the ROD was signed, it was determined that GMT1 and GMT2 were not located in the same reservoir as the other Alpine satellites. In 2008, the GMT Unit (GMTU) was formed within the NPR-A, and satellites CD6 and CD7 were officially renamed GMT1 and GMT2.

In 2012, the BLM prepared the NPR-A Integrated Activity Plan (IAP)/EIS, a leasing and land management plan for over 22 million acres of BLM-managed land in the NPR-A. In 2014, the BLM completed a SEIS to evaluate the proposed GMT1 Development Project. The GMT2 SEIS tiers to these previous analyses and incorporates new data and site-specific information. The Alaska National Interest Lands Conservation Act (ANILCA) § 810 evaluations for these plans are summarized in GMT2 SEIS § 1.4.3.1.

The current proposal for development of the GMT2 drill site has been revised since the BLM authorized it in the 2004 ASDP ROD. Notable revisions include:

- A large portion of the GMT1-GMT2 access road and pipelines were located within the 3-mile Fish Creek Setback in the 2004 design. In the 2014 design, the drill pad was located in the Colville River Special Area. In response to public input, the current design locates the drill pad north of the Colville River Special Area and avoids the Fish Creek Setback.

- The size of the proposed GMT2 drill pad, previously 9.1 acres, is now 14 acres to accommodate 48 wells, compared to 20 wells permitted in 2004.

- The proposed 8.2-mile GMT1-GMT2 access road is 1.8 miles longer than the CD6-CD7 road permitted in 2004 because of the relocation of the Nigliq Channel bridge and relocation of the GMT1 and GMT2 drill pads.

- The proposed GMT2 project's total gravel footprint is 78 acres compared to 50.6 acres permitted in 2004. The total gravel requirement is 671,300 cubic yards compared to 339,000 cubic yards permitted in 2004.

- The proposed GMT1-GMT2 access road design currently includes three 1.2-acre vehicle pullouts to accommodate use, entrance, and egress of the road corridor by subsistence users and overland travelers with highway vehicles, snowmachines, and four-wheelers.

- The proposed gravel source for the project was originally the Clover Site, which is located on BLM-managed lands. The gravel source currently proposed is the Arctic Slope Regional Corporation (ASRC) mine site, located 4.5 miles east of Nuiqsut.

These modifications to the proposed project, the length of time that has passed since issuing the 2004 ASDP ROD, the level of public interest in the project, construction of the Nuiqsut Spur Road in 2014-15, and updated subsistence harvest and use pattern data were among the factors the BLM considered in its decision to prepare a SEIS for the GMT2 Development Project.

Chapters 3 and 4 of the GMT2 SEIS describe the current environmental status of the project area and potential effects of the alternatives to subsistence and subsistence resources. This appendix uses that information to evaluate potential impacts to subsistence pursuant to § 810(a) of ANILCA as directed in BLM IM AK-2011-008.

A.1 SUBSISTENCE EVALUATION FACTORS

Section 810(a) of ANILCA, 16 United States Code (USC) § 3120(a), requires that an evaluation of subsistence uses and needs be completed for any federal determination to "withdraw, reserve, lease, or otherwise permit the use, occupancy or disposition of public lands." The GMT2 drill pad, sections of the GMT2 gravel access road (under Alternatives A and B) and sections of the pipeline and ice road (under all action alternatives) are on BLM-managed lands and require BLM authorization. Thus, evaluation of potential impacts to subsistence under ANILCA § 810(a) must be completed for the GMT2 project. Evaluations of all impacts to subsistence uses and needs apply regardless of land status.

ANILCA requires that this evaluation includes findings on 3 specific issues:

1) The effect of use, occupancy, or disposition on subsistence uses and needs;
2) The availability of other lands for the purposes sought to be achieved; and
3) Other alternatives that would reduce or eliminate the use, occupancy, or disposition of public lands needed for subsistence purposes (16 USC § 3120(a)).

Three factors are considered when determining if a significant restriction of subsistence uses and needs may result from the proposed action and alternatives or in the cumulative case:

1) Reductions in the abundance of subsistence resources caused by a decline in the population or amount of harvestable resources;
2) Reductions in the availability of resources used for subsistence purposes caused by alteration of their normal locations, migration, or distribution patterns; and,
3) Limitations on access to subsistence resources, including from increased competition for the resources (BLM IM AK-2011-008).

A finding that the proposed action may significantly restrict subsistence uses initiates requirements to notify the State of Alaska and appropriate regional and local subsistence committees, hold hearings in the affected communities, and make the following determinations before the BLM can authorize use of the public lands:

1) Such a significant restriction of subsistence uses is necessary, consistent with sound management principles for the utilization of the public lands;
2) The proposed activity will involve the minimal amount of public lands necessary to accomplish the purposes of the use, occupancy, or other disposition; and
3) Reasonable steps will be taken to minimize adverse effects upon subsistence uses and resources resulting from such actions (§ 810(a)(3)).

A proposed action and/or alternative would be considered to significantly restrict subsistence uses if, after consideration of stipulations or protection measures (i.e., lease stipulations, Best Management Practices (BMPs), etc.) included as a part of each alternative, it can be expected to result in a substantial reduction in the opportunity to continue subsistence uses of renewable resources. Substantial reductions in the opportunity to continue subsistence uses generally are caused by large reductions in resource abundance, a major redistribution of resources, extensive interference with access, or major increases in the use of those resources by non-subsistence users (BLM IM AK-2011-008).

In addition to ANILCA, Environmental Justice, as defined in Executive Order 12898, calls for an analysis of the effects of federal actions on minority populations with regard to subsistence. Specifically, Environmental Justice is:

> *The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including a racial, ethnic, or socioeconomic group should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies* (EPA, 2016).

Section 4-4 of the Executive Order on Environmental Justice, regarding the Subsistence Consumption of Fish and Wildlife, requires federal agencies to collect, maintain, and analyze information on the consumption patterns of populations who principally rely on fish and/or wildlife for subsistence, and to communicate to the public any risks associated with those consumption patterns. To this end, the subsistence analyses of all alternatives, located in Chapter 4 of the SEIS, have been reviewed and found to comply with Executive Order 12898.

A.2 ANILCA § 810(a) Evaluations and Findings for All Alternatives and the Cumulative Case

Evaluations and findings for Alternatives A, B, C, and D and the cumulative case, are presented individually in the following sections. BMPs established by the 2013 ROD for the NPR-A IAP/EIS would apply to all GMT2 SEIS alternatives. ConocoPhillips' leases in the GMTU are subject to lease stipulations established in the 2008 ROD for the Northeast NPR-A. The mitigating impacts of these BMPs and lease stipulations are accounted for in the following evaluations and findings, however potential new mitigation measures analyzed in the SEIS are not incorporated because, until the GMT2 ROD is issued, it is not known whether they will be adopted.

A.2.1 Evaluation and Findings for Alternative A

Development of oil reserves at the GMT2 site would occur under Alternative A. Infrastructure would include a drill site on BLM-managed land in the GMTU, an 8.2-mile access road between GMT1 and

GMT2, pipelines on BLM-managed and private lands in the NPR-A, and a pipeline and pipe rack on private and state lands outside the NPR-A.

The BLM developed two project areas to quantify impacts to subsistence use areas during the construction phase and the drilling and operations phases. Both project areas were established by creating a 2.5-mile buffer around all project activity and infrastructure that would occur during each phase. The 2.5-mile buffer was established based on displacement distances evaluated in studies of caribou behavioral responses to disturbance (see GMT2 SEIS § 4.4.5).

The GMT2 construction project area encompasses 158,480 acres (Figure 1). It includes the community of Nuiqsut, the gravel mine located 4.5 miles northeast of Nuiqsut, the Alpine Central Processing Facility (CPF), CD2, and CD4 in the Colville Delta north of Nuiqsut, bridges over the Nigliq Channel of the Colville River (and 3 smaller bridges between the Nigliq and CD5 and over the Ublutuoch River), the CD5 drill site, the CD5-GMT1 access road, the GMT1 drill site northwest of Nuiqsut, and the proposed GMT1-GMT2 access road and GMT2 drill site west of Nuiqsut.

The GMT2 drilling and operations project area encompasses approximately 97,900 acres (Fig. 1) and includes the Alpine CPF, CD2, and CD4 in the Colville Delta north of Nuiqsut, bridges over the Nigliq Channel of the Colville River (and 3 smaller bridges between the Nigliq and CD5 and over the Ublutuoch River), the CD5 drill site, the CD5-GMT1 access road, the GMT1 drill site northwest of Nuiqsut, and the proposed GMT1-GMT2 access road and GMT2 drill site west of Nuiqsut.

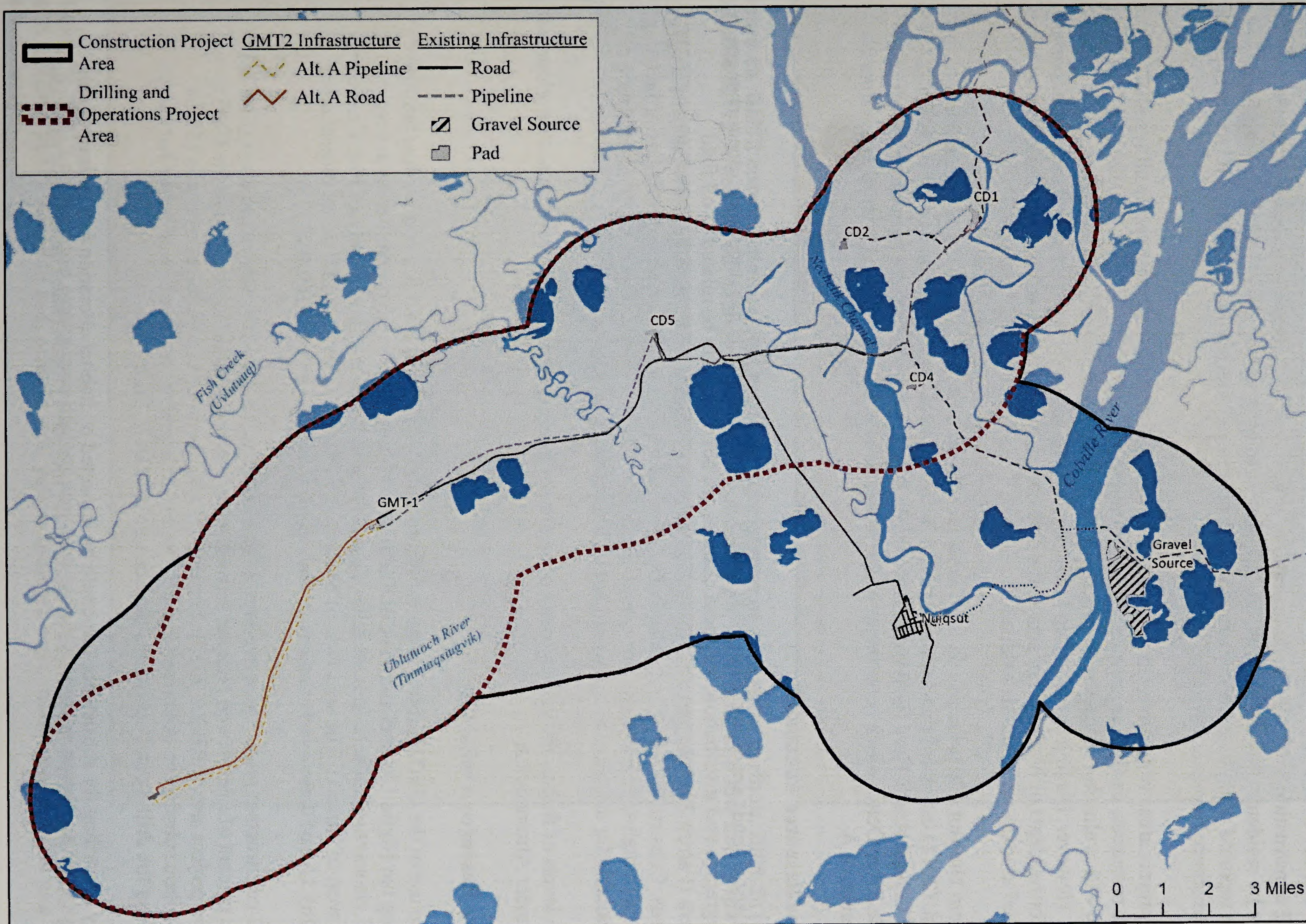

Figure 1. GMT2 construction and drilling and operations project areas and proposed and existing infrastructure in the vicinity of Nuiqsut, Alaska.

A.2.1.1 Evaluation of the Effect of Use, Occupancy, or Disposition on Subsistence Uses and Needs

The GMT2 construction and drilling and operations project areas lie within areas heavily used for subsistence by residents of Nuiqsut (Figs. 2a, 2b). All of Nuiqsut active harvesters interviewed from 1995-2006 reported using both the construction project area and the drilling and operations project area to harvest subsistence resources (SRB&A 2010b).

While the project areas would overlap areas used by Nuiqsut residents to harvest nearly all types of subsistence resources, caribou are particularly important to the community (Brown et al. 2016). Thus, this ANILCA § 810 evaluation focuses primarily on impacts affecting the abundance, availability, and access to caribou. However, hunting and trapping furbearers (specifically wolf and wolverine) are also important activities for residents of Nuiqsut. Impacts to the abundance, availability, and access to these resources are described as appropriate in this evaluation.

Hunters from Nuiqsut rely primarily on the Teshekpuk Caribou Herd (TCH) (87% of annual harvest), but Braem et al. (2011) estimated that approximately 13% of the total annual caribou harvest by Nuiqsut consists of Central Arctic Herd (CAH) animals (Parrett 2015). CAH animals are harvested primarily in the Colville River Delta, which is northeast of the project area and unlikely to experience direct impacts under Alternative A.

Subsistence Resource Abundance

TCH population trends are discussed in GMT2 SEIS § 3.3.4.1. The TCH has undergone recent changes in size, demography, and distribution, but these changes are not thought to be related to oil field development (Parrett 2015, Lenart 2015). The GMT2 project areas overlap only the lowest density TCH calving areas. Construction or operation activities would not affect large numbers of pregnant or lactating cows' access to high-quality forage, nor would they affect calf production. Therefore, the abundance of caribou available for subsistence use would not be impacted under Alternative A.

Population levels of furbearers on the coastal plain are not likely to be impacted by proposed development activities under Alternative A.

Subsistence Resource Availability

Subsistence use of the GMT2 project areas is discussed in GMT2 SEIS § 4.4.5. Most caribou hunting occurs along the Nigliq Channel and the Colville River via boat, and in two primary areas accessed "overland" via snowmachine or four wheeler: 1) northwest of Nuiqsut in the vicinity of Fish Creek, and 2) directly west of Nuiqsut. The area west of Nuiqsut is within and directly south of the project areas (Figs. 2a, 2b). Use of these overland areas has increased in recent years (SRB&A 2017a).

The GMT2 construction project area overlaps 25% of overland caribou subsistence use areas (Fig. 2a). Ninety one percent of interviewed Nuiqsut active harvesters reported hunting caribou in the GMT2 construction project area (SRB&A 2017). The drilling and operations project area overlaps 13% of overland caribou subsistence use areas (Fig. 2b). Eighty four percent of interviewed active harvesters reported using the drilling and operations project area (SRB&A 2017).

Availability of caribou for subsistence use could be impacted by habitat alteration and anthropogenic disturbance under Alternative A. Sources of disturbance include 1) road-related disturbance associated

with the GMT1-GMT2 access road (presence of road, vehicle traffic, and design features (e.g. height) of the road), and 2) aircraft traffic.

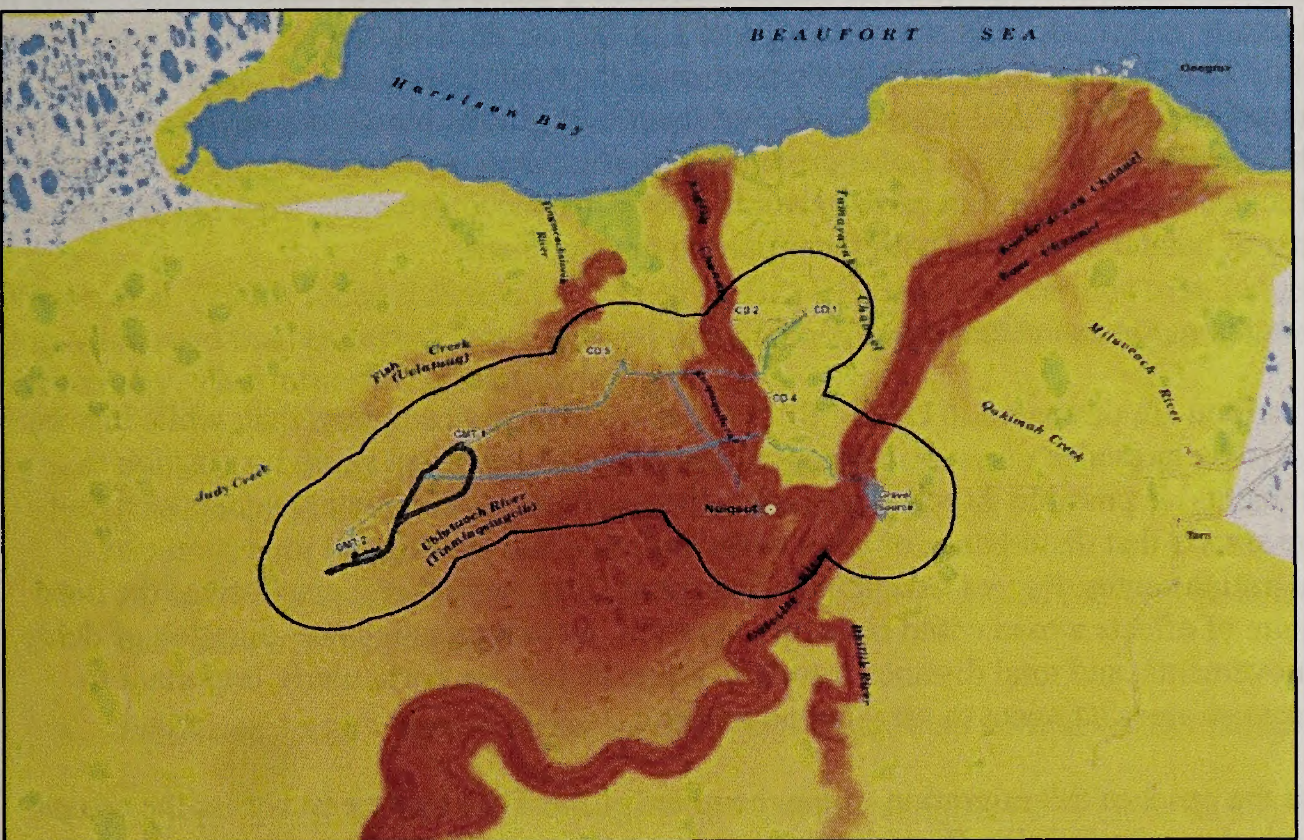

Figure 2a. GMT2 construction project area and subsistence use areas for caribou, 2008-2015 (SRB&A 2017). Areas in red, orange, and yellow indicate high, moderate, and low use respectively.

Figure 2b. GMT2 drilling and operations project area and subsistence use areas for caribou, 2008-2015 (SRB&A 2017). Areas in red, orange, and yellow indicate high, moderate, and low use respectively.

Displacement of caribou due to habitat loss

Habitat-related impacts to caribou are discussed in the GMT2 SEIS § 4.3.4.1. Thirty eight percent of the construction project area overlaps the TCH range (60,634 of 158,480 acres), and consists of 0.2% of the herd's range (60,634 of 33,673,144 acres). Fifty seven percent of the drilling and operations project area overlaps the TCH range (55,934 of 97,921 acres), and consists of 0.2% of the herd's range. Impacts to habitat would be low (GMT2 SEIS § 4.3.4). Local displacement of caribou in areas where forage habitat is lost due to infrastructure would occur, but caribou would not be displaced generally from the project areas due to direct loss of habitat associated with the proposed development.

Displacement of caribou due to road disturbance

Impacts of roads on caribou are discussed in GMT2 SEIS § 4.3.4.1. Research suggests that, while historic caribou ranges persist in the presence of roads, a range of reactions to a new road (from no reaction to dramatic, novel movements) is possible. Mechanisms of disturbance are not completely understood, but traditional knowledge asserts that disturbance of adult cows initiating and leading fall migration can disrupt traditional migration routes. Recent research (Wilson et al. 2016 and others) emphasizes the need to consider the full suite of effects a road could have on migration, including avoidance, duration of delay, speed of migratory movements, and total distance traveled. These factors are particularly important to consider in subsistence use areas adjacent to rural communities.

In late summer and at the onset of fall migration, some members of the TCH move east across the coastal plain and migrate south along the Colville River in the vicinity of Nuiqsut (Fig. 3, Panel G, H). The GMT1-GMT2 access road would bisect this migration corridor. Five percent of GPS-collared caribou crossed the proposed alignment during fall migration between 2005 and 2017 (Lawhead et al. 2015, L. Parrett pers. comm.). Annual crossing rates vary considerably, ranging from 0% to 31%. Considering these figures with respect to the herd's current size (56,000 animals), anywhere from 0 (0%) to 17,360 (31%) animals are likely to encounter the road in a given year, with approximately 2,800 (5%) encountering the road annually.

Use of the migration corridor west of the Colville River is low when considered relative to the herd's migratory movements as a whole, as evident by 5% of collared caribou crossing the proposed alignment over 12 years. However, caribou using migration routes on the eastern edge of the herd's range are most easily accessible by Nuiqsut hunters. Thus, the small portion of the herd that uses this eastern migration route is particularly important to the community. Its importance has likely increased in recent years, as use of the GMT2 project areas during August and September has increased (GMT2 SEIS Figs. 3.4-17, 3.4-18).

The most analogous case study for road impacts to caribou is the CD5-GMT1 access road, constructed in 2015. While it is east of the proposed GMT1-GMT2 access road, and therefore further on the periphery of the TCH range, it is similar in terms of location, length, orientation, and proximity to Nuiqsut's caribou subsistence use area. The road has not been in place long enough for researchers to document caribou responses to it via multi-year collar data (L. Parrett, pers. comm.). The 2016 and 2017 caribou harvests were similar to harvest levels observed prior to construction. Hunting trip duration has not changed in recent years, but trip duration data have not been collected since the CD5-GMT1 access road was built (GMT2 SEIS Table 4.4.8). Some Nuiqsut hunters and Native Village of Nuiqsut (NVN) Tribal Council members reported reduced availability of caribou south of the road, although whether this is attributable to the road is unknown.

Wilson et al. (2016) explored the effects of the Red Dog Mine road on individual caribou movements during fall migration. It is important to highlight the differences between the Red Dog Mine road and

proposed GMT1-GMT2 access road. The Red Dog Mine road is much longer (50 miles total) than the GMT1-GMT2 access road, and is primarily within the range of the Western Arctic Herd. Traffic consists of large trucks transporting ore, often in convoys. While large equipment would use the GMT1-GMT2 access road, use would be periodic as opposed to regularly scheduled. However, the roads would share similarities: they are oriented somewhat perpendicular to fall migration paths and are similar both in terms of design features and traffic rates. Considering the results and subsequent discussion of this study is worthwhile in the absence of concrete conclusions regarding caribou interactions with the CD5-GMT1 access road.

Wilson et al. (2016) found that 8 out of 28 (29%) GPS-collared cow caribou took longer to cross the Red Dog Mine road than expected. They defined these animals as “slow crossers” and “normal crossers” respectively. They observed the following:

- *Avoidance* - once they came within approximately 10 miles of the road, slow crossers took an average of 33 days to cross it. Normal crossers took 3 days.

- *Delay* - slow crossers delayed crossing the road. They crossed the road an average of 2 weeks later than normal crossers.

- *Increased speed* - slow crossers traveled 60% faster than normal crossers after crossing the road.

- *Increased movements* - slow crossers traveled an average of 273 miles farther over the course of fall migration, and wintered farther south.

Wilson et al. were unable to offer definitive reasons for why the road elicited responses from some caribou and not others, but they do outline and explore multiple theories. They cite other studies demonstrating life history condition (e.g. pregnant cows) affects individual response to infrastructure, and explore the concept of social cues and their potential indirect impact on herd-wide movements (aligned with the long-held belief that lead cows must not be disrupted during fall migration). They consider the implications of environmental and context specific variables (e.g. traffic type), but ultimately conclude that reactions to roads are individual and context dependent, and can vary greatly from year to year.

It is possible that none, some, or all of the TCH animals using the migration route west of Nuiqsut would react to the GMT1-GMT2 access road in a manner similar to those described by Wilson et al. (2016). Likely, at least some animals will demonstrate avoidance, delay, increased speed, or increased movements, whether annually or on an interannual basis. It is impossible to know definitively, and thus accurately predict impacts to subsistence. However, if 29% of the caribou encountering the road exhibit these responses, as was observed by Wilson et al., it is reasonable to expect that subsistence hunters would take more trips and expend more time and resources in search of caribou. It is possible that their seasonal round would be affected, as some caribou may move through Nuiqsut’s subsistence use area later in the year. This would have implications for those hunting by boat along the Colville River, as icing would preclude continued use of the river late in the year. Caribou could also move through Nuiqsut’s subsistence use area faster during fall migration, limiting the time that sufficient numbers of caribou are available for harvest, particularly in the area directly west of Nuiqsut which is easily accessible during day trips.

There is substantial compounding uncertainty associated with the impacts of the GMT1-GMT2 access road on subsistence. The literature does not yet offer broad scale, predictive conclusions regarding caribou responses to roads that bisect migration routes. Caribou responses to this specific road are unknown and likely would be highly variable. Hunter success is highly contingent on numerous factors. Also, hunters’ ability to adapt to changes in resource availability is substantial. It is likely that many

hunters could overcome issues associated with the road and caribou availability. However, potential consequences of altered caribou availability could result in increases in trip duration or frequency. If this occurs over the expected life of the project, Nuiqsut hunters lacking adequate time, income, or equipment could experience a significant resctiction due to the reduced local availability of caribou to meet their needs.

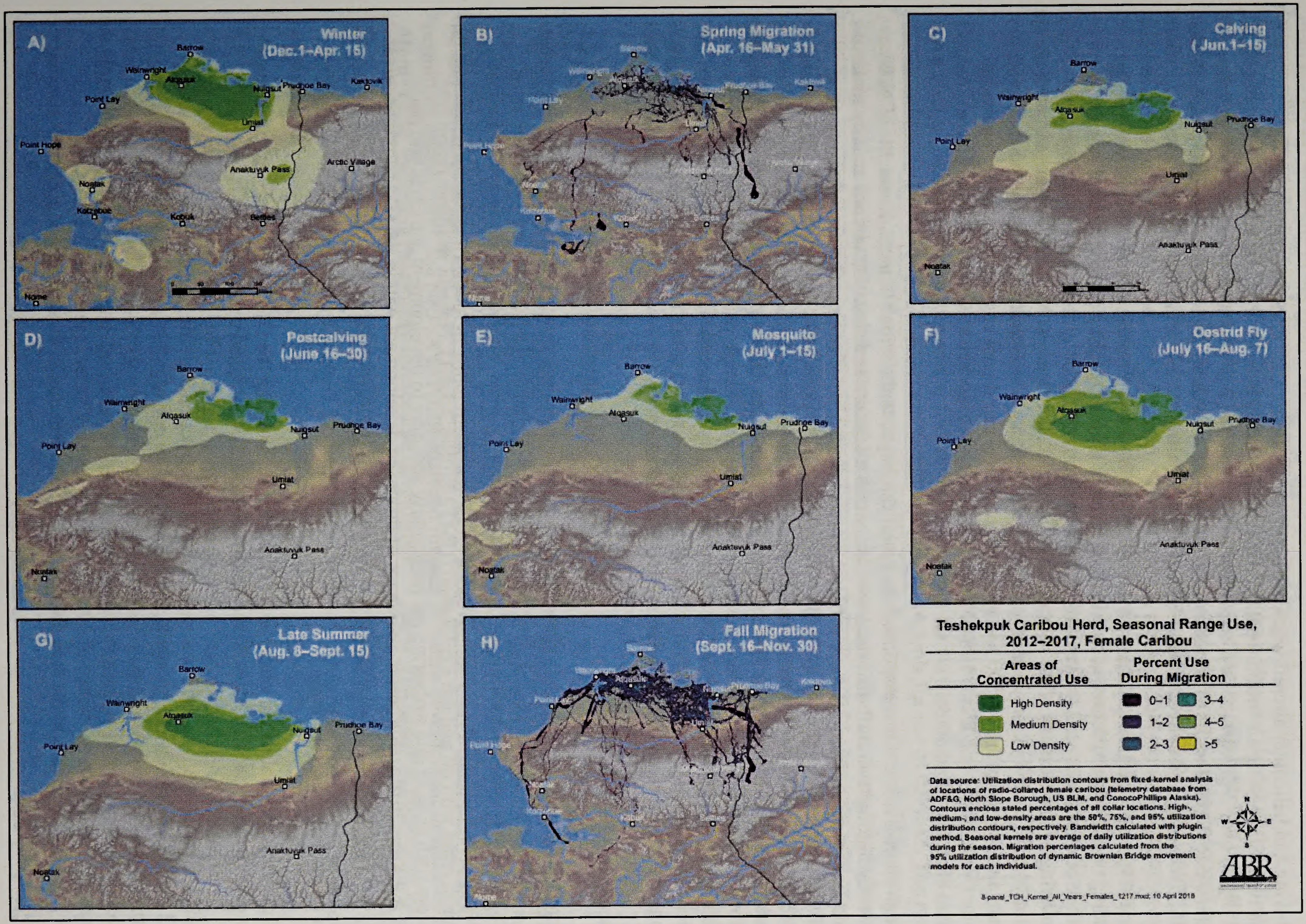

Figure 3. Teshekpuk Caribou Herd seasonal range use, 2012-2017, based on GPS-collared cow caribou (ABR unpublished data, 2018).

Displacement of caribou due to aircraft disturbance

Fixed-wing and helicopter aircraft would be based at the Alpine CPF during construction for all alternatives. Fixed-wing air traffic would consist of 270 flights over the 2-3 year period. Helicopter traffic (1032 flights over 2-3 years) would be present within the GMT2 project area from May to September and would include flights required for monitoring studies, ice road clean-up, and emergency response. A total of 1302 fixed-wing and helicopter flights would occur during the 2-3 year construction phase.

Caribou response to aircraft is discussed in GMT2 SEIS § 4.3.4.1. Caribou response to aircraft varies depending on the season, degree of habituation, aircraft, altitude, flight patterns, weather conditions, frequency of overflights, and the sex and age composition of caribou groups. Low-level flights or maneuvering in the presence of un-habituated caribou can elicit escapist behavior (increased speed, abrupt direction change). Alternatively, caribou can become habituated to aircraft; particularly when aircraft maintain altitudes greater than 500 feet above ground level and do not engage in hazing or harassing behavior (Valkenburg and Davis 1983). In general, caribou responses to aircraft tend to be short-lived (Fullman et al. 2017 and others).

Although short-lived, caribou responses to aircraft can impact subsistence hunters. Residents of Nuiqsut consistently highlight aircraft disturbance of caribou as a concern and state that aircraft activity makes animals more wary and harvest more difficult. Further discussion of community concerns regarding aircraft disturbance of caribou is in GMT2 SEIS § 4.4.5 and Appendix K. Caribou harvest has remained consistent despite increased air traffic in the vicinity of Alpine and other new infrastructure, and mitigation measures have been implemented to alleviate impacts. However, residents consistently say that the effort required to harvest resources is acutely disturbed by aircraft, particularly helicopter traffic. Assessing potential impacts of aircraft traffic considers Inupiaq hunters' traditional knowledge and observations, the consistent North Slope Borough-wide opposition to aircraft traffic during the caribou hunting season, and research on aircraft noise effects on animals.

Displacement of furbearers

Furbearer subsistence use area data show high overlapping use areas throughout the GMT2 project areas (GMT2 SEIS Appendix F, Fig. F-5, Brown et al. 2016). One hundred percent of wolf and wolverine hunters reported hunting or trapping furbearers in the project areas. Studies in Canada and Scandinavia have shown that wolverines are more abundant in areas without development and that they are less likely to occur in areas with oil and gas exploration (GMT2 SEIS § 3.3.4.1). Nuiqsut residents report that furbearers such as wolf and wolverine are particularly sensitive to development activities and noise (SRB&A 2009a, 2010b). Furbearer avoidance of proposed development within the GMT2 project areas would likely necessitate further travel and increased effort (time, resources) in pursuit of these resources.

Access to Subsistence Resources

Use of the industry-established safety area (1,000 feet surrounding the GMT2 drill pad) by subsistence users would be prohibited during both the construction and drilling and operations phases.

Ice roads and pads would be used to support GMT2 construction activities during three winter seasons (GMT2 SEIS Map 2.5-3). The ice roads and pads would be open for 80 days (February 1 – April 20), however construction would begin in November and clean-up would extend to late spring/early summer. Subsistence use of or travel on ice roads and pads would be prohibited, and shooting across or towards the ice roads and pad within a distance of 2 miles presents a safety hazard (see GMT2 SEIS § 4.4.5.1). Access would be restricted in the area directly west of Nuiqsut due to these safety concerns for the first

construction season (November to May) while the ice road is being constructed and gravel is being hauled from the ASRC mine site to the GMT2 site.

During construction, the GMT1-GMT2 access road would introduce a physical barrier to travel through the area by snowmachine or four-wheeler. These impacts could occur during summer, fall, or winter caribou hunting, winter furbearer hunting and trapping, and spring geese hunting. Impacts related to man-made structures were the second most commonly reported impact in 2014 (SRB&A 2016), before ramps had been constructed to cross the new CD5 road. Several hunters reported that man-made structures blocked access when traveling overland, and hunters were required to go around the road to access areas to the north and west. While the GMT1-GMT2 access road is being constructed, but before it is open to public use, subsistence hunters will be able to access land north and west of the community. They can do this by traveling overland and crossing the CD5-GMT1 road at one of three crossing locations with ramps, or driving to one of the ramp locations via the Kuukpik Spur Road and CD5-GMT1 road.

The GMT1-GMT2 access road would be open to Nuiqsut subsistence users once construction is completed and a road access agreement is finalized. The road access agreement would likely be similar to the agreement for the CD5-GMT1 road, and would list the requirements for use of the road. The road would facilitate access to subsistence use areas west of Nuiqsut. Subsistence users would be permitted to use designated pullouts or parking areas along the road. They could use snowmachines, four-wheelers, vehicles, or a combination thereof (via trailering) along the road. Many would egress the road corridor and continue hunting overland. Subsistence hunters with authorized vehicles and permission from the Kuukpik Corporation to use the Spur Road or access Kuukpik lands would likely benefit directly from this facilitated access. Hunters who lack appropriate authorization would not benefit from the road.

The road would continue to act as an impediment to overland travel (snowmachines and four-wheelers) throughout the drilling and operations phase. Users would be able to cross the road using the ramps, but may have to reroute their direction of travel based on the location of the ramps.

A.2.1.2 Evaluation of the Availability of Other Lands

The Naval Petroleum Reserves Production Act of 1976 (NPRPA), as amended, instructs the Secretary of the Interior to conduct oil and gas leasing in the NPR-A. Congress authorized petroleum production in 1980, and directed the Secretary of the Interior to undertake a program of competitive leasing of potential oil and gas tracts in the Reserve. In 2004, the ASDP ROD approved the GMT2 (then CD7) project for permitting, and in 2013, the NRP-A IAP/EIS analyzed impacts of future development in and around the Alpine Field, including reasonably foreseeable development of the GMT2 site. The purpose of the GMT2 SEIS is to consider any new and site-specific information relevant to this previously authorized project. The proposed project was designed to develop oil from a delineated oil field on valid leases within the Petroleum Reserve. Other lands managed by the BLM are too distant to access the GMTU reservoir using current drilling technologies.

A.2.1.3 Evaluation of Other Alternatives that Would Reduce or Eliminate the Use, Occupancy, or Disposition of Public Lands Needed for Subsistence Purposes

Alternative D would reduce or eliminate the use of public lands needed for subsistence purposes. However, the BLM may not select Alternative D as its preferred alternative. The BLM issued leases to ConocoPhillips, and is required to allow reasonable development of those leases.

GMT2 SEIS § 2.4.2 discusses other alternatives that were considered but eliminated from detailed analysis due to economic or technological disadvantages, or because they did not meet the purpose of the proposed action to produce the oil discovered on ConocoPhillips' leases.

A.2.1.4 Findings

This evaluation concludes that Alternative A may result in a significant restriction to subsistence uses for the community of Nuiqsut due to impacts to caribou and furbearer availability. This finding requires a positive determination pursuant to ANILCA § 810.

The GMT1-GMT2 access road and aircraft traffic may alter late summer and fall movements of TCH caribou in the vicinity of Nuiqsut. While the magnitude of the impact with respect to the TCH as a whole would be small, it could be substantial given the significance of the portion of the herd that ranges close to Nuiqsut (Fig. 3). Caribou movements could be altered through the life of the project, as high inter-annual variability and overall low use makes the likelihood that a caribou would encounter the road multiple times during its lifetime, and thus become habituated to it, low. The extent of the impact could encompass important and easily accessible areas used by Nuiqsut hunters, namely along the Colville River and the area west of Nuiqsut and south of the proposed road. The basis for this finding relies heavily on the project's proximity to this core subsistence use area. Current research and preliminary reports by subsistence users suggest that caribou availability could be impacted (SRB&A 2017). The likelihood of the impact occurring is difficult to determine, given the compounding uncertainty associated with caribou's reactions to roads, hunters' response to changing resource distribution, and natural variation at multiple geographic scales. BLM policy directs the BLM to err on the side of protection in cases of uncertainty such as this (BLM IM AK-2011-008, pgs. 6-2, 6-3).

Wolf and wolverine avoidance of infrastructure is well documented (SRB&A 2009a, 2010b). It is likely that subsistence hunters targeting furbearers would need to relocate trap lines due to reduced availability of these resources in the vicinity of the GMT2 project areas.

A.2.2 Evaluation and Findings for Alternative B

The GMT1-GMT2 access road follows the watershed boundary between Fish Creek and the Tinmiaqsiugvik River under Alternative B. The road would be 1.2 miles longer and require additional gravel.

A.2.2.1 Evaluation of the Effect of Use, Occupancy, or Disposition on Subsistence Uses and Needs

The effects of Alternative B on subsistence would be similar to those described for Alternative A with one important difference: greater impacts during construction due to increased industrial traffic and activity (i.e., gravel hauling and gravel mining) associated with the longer road. Under Alternative B, the road and pipeline would be slightly closer to Nuiqsut than under Alternative A. Some residents perceive an advantage in keeping industrial activities as close as possible to town, thereby leaving the more remote hunting areas less affected. This is advantageous for those with the means and time to travel and hunt remote areas but disadvantageous for those who depend on hunting close to town. In the case of GMT2, the long-term differences in direct impacts between alternatives A and B are not considered significant because neither route includes bridges or is located within a setback.

A.2.2.2 Evaluation of the Availability of Other Lands

The evaluation for GMT2 SEIS Alternative B is identical to that provided above in § A.2.1.2.

A.2.2.3 Evaluation of Other Alternatives that Would Reduce or Eliminate the Use, Occupancy, or Disposition of Public Lands Needed for Subsistence Purposes

The evaluation for GMT2 SEIS Alternative B is identical to that provided above in § A.2.1.3.

A.2.2.4 Findings

This evaluation concludes that Alternative B may result in a significant restriction to subsistence uses for the community of Nuiqsut due to impacts to caribou and furbearer availability. This finding requires a positive determination pursuant to ANILCA § 810.

With the exception of the difference in effects noted above, the rationale for these findings under Alternative B are identical to those for Alternative A.

A.2.3 Evaluation and Findings for Alternative C

GMT2 SEIS Alternative C would not include the GMT1-GMT2 access road. Under this alternative, transportation to the GMT2 site would be by aircraft approximately 9 months of the year (May through January) and primarily via ice road approximately three months of the year (February through April). An airstrip, associated parking apron, storage building, and a gravel pad second gravel pad to accommodate a camp and additional facilities would be constructed, along with a 0.9 mile access road connecting the airstrip with the drill site and occupied pad.

Movement of the drill rig to and from other drill sites would take place when the ice-road is open. The drill pad would be larger and numerous additional facilities would be required, including a mud plant and cement facility, a class-one disposal well, drilling and mud plant water supply, an incremental 150-man construction support camp, a 75-man drill rig support camp, a permanent full-service operations camp, a water and wastewater treatment plant, a 2-inch potable water pipeline, and other additional infrastructure required for a stand-alone facility. Construction of infrastructure would require 45-50% more gravel, and the total footprint of Alternative C would be 92 acres greater than Alternatives A or B. Water use would be greater due to annual ice road construction and additional man camp and industrial facilities. Air pollution emissions would be greater due to more facilities at the GMT2 site, annual ice road construction, and increased air traffic.

A.2.3.1 Evaluation of the Effect of Use, Occupancy, or Disposition on Subsistence Uses and Needs

Subsistence Resource Abundance

The evaluation for GMT2 SEIS Alternative C is identical to that provided above in § A.2.1.1.

Subsistence Resource Availability

GMT2 SEIS § 4.4.3.3 considers reduced availability of subsistence resources. Many effects on subsistence uses from Alternative C would be different than under Alternatives A and B, although reduced availability of caribou, wolves, and wolverine are anticipated.

Alternative C could create impacts to caribou hunting due to increased air traffic. The lack of a gravel road would reduce physical disruption of caribou movement, specifically during fall migration. However, increased air traffic, may reduce localized availability of caribou. Alternative C would result in more air traffic in important hunting areas west of the Nuiqsut and would create a new and significant source of air traffic that did not exist before (GMT2 SEIS § 4.4.5.5). GMT2 SEIS Table 2.9-3 summarizes the total number of projected aircraft flights over the course of construction, drilling, and operations under Alternatives A, B, and C. Alternative C would consist of 81% more flights over the course of the project. Helicopter traffic would be 30% higher.

The GMT2 SEIS describes impacts of aircraft on caribou. Numerous studies have documented general behavioral responses ranging from escapist behavior to no observable effect. Caribou ultimately appear to habituate to aircraft when aircraft consistently maintain altitudes greater than 500 feet above ground level and do not engage in hazing or harassing behavior (Webster 1997). Despite this, Nuiqsut caribou hunters cite aircraft traffic as the most common impact on caribou. They believe that increased air traffic diverts caribou away from hunting areas, and make caribou more wary and difficult to approach, resulting in reduced harvest opportunities. Given these consistent concerns and observations, it is likely that availability of caribou would be impacted under Alternative C.

Residents have indicated that furbearers such as wolf and wolverine are particularly sensitive to development activities and noise (SRB&A 2009a, 2010b). It is likely that displacement of furbearers from the GMT2 project area would cause hunters to travel farther looking for these resources. Alternative C will have the highest traffic levels during the routine operations period due to exclusively utilizing ice roads for all vehicle traffic, which will result in reduced availability of resources in areas where they are traditionally harvested.

Access to Subsistence Resources

Ice roads would be adverse for wintertime furbearer hunting and trapping activities. Routes that bisect or overlay trap lines force trappers to relocate from traditional trapping areas.

A.2.3.2 Evaluation of Availability of Other Lands

The evaluation for GMT2 SEIS Alternative C is identical to that provided above in § A.2.1.2.

A.2.3.3 Evaluation of Other Alternatives that Would Reduce or Eliminate the Use, Occupancy, or Disposition of Public Lands Needed for Subsistence Purposes

The evaluation for GMT2 SEIS Alternative C is identical to that provided above in § A.2.1.3.

A.2.3.4 Findings

This evaluation concludes that Alternative C may result in a significant restriction to subsistence uses for the community of Nuiqsut due to impacts to caribou and furbearer availability, and access to furbearers. This finding requires a positive determination pursuant to ANILCA § 810.

Increased air traffic would likely make harvesting caribou more difficult, particularly in the vicinity of frequently used flight paths. Displacement would occur west of Nuiqsut in an important and easily accessible hunting area. The basis for this finding relies heavily on the project's proximity to this core subsistence use area. Periodic displacement would persist through the life of the project.

Ice roads and infrastructure would likely result in substantial displacement of furbearers that are sensitive to development. Displacement would occur within the project area, which is within Nuiqsut's subsistence use area for furbearers. Displacement would persist through the life of the project. This substantial amount of displacement of furbearers from important harvest areas is expected to result in a major redistribution of furbearers, and thus may significantly restrict subsistence uses.

A.2.4 Evaluation and Findings for Alternative D

GMT2 SEIS Alternative D (No Action) precludes the currently proposed development in the GMTU. Oil from the GMT2 field would not be produced. New roads, airstrips, pipelines or other oil and gas facilities would not be constructed pursuant to ConocoPhillips' application.

Other activities that are currently allowed pursuant to the 2013 NPR-A IAP/EIS ROD would continue. These activities include seismic exploration, exploratory drilling of test wells, and the construction of ice roads and pads to support these operations.

A.2.4.1 Evaluation of the Effect of Use, Occupancy, or Disposition on Subsistence Uses and Needs

Impacts to subsistence would not be expected under Alternative D.

A.2.4.2 Evaluation of the Availability of Other Lands

Alternative D does not propose the disposition or use of public lands with regard to the proposed action. Therefore, evaluating the available of other lands is not applicable.

A.2.4.3 Evaluation of Other Alternatives that would Reduce or Eliminate the Use, Occupancy, or Disposition of Public Lands Needed for Subsistence Purposes

Alternative D would eliminate the use of public lands needed for subsistence purposes, but does not meet the purpose of the proposed action, nor does the BLM have authority to select this alternative because the right to drill is associated with these leases.

GMT2 SEIS § 2.4.2 discusses alternatives that were considered but eliminated from detailed analysis due to economic or technological disadvantages, or because they did not meet the purpose of the proposed action.

A.2.4.4 Findings

This evaluation concludes that Alternative D (No Action) would not result in a significant reduction in subsistence uses. A positive determination pursuant to ANILCA § 810 is not required.

A.2.5 Evaluation and Findings for the Cumulative Case

GMT2 SEIS § 4.6 contains a detailed description of the cumulative case, which evaluates the impact of the proposed action in conjunction with all past, present, and reasonably foreseeable future activities in the Colville River watershed and Nuiqsut subsistence use area. It considers, in detail, activities that are more certain to happen, and gives special attention to activities that have been identified as being of concern to subsistence users.Past, present and reasonably foreseeable future developments (RFFDs) within 40 miles of Nuiqsut are presented in GMT2 SEIS Table 4.6-2. Existing oil development within this area includes approximately 1,702 development wells, 48 miles of pipeline, 240 miles of permanent gravel road, and 791 acres of surface development.

Reasonably foreseeable oil development within 40 miles of Nuiqsut will result in hundreds of additional development wells and several miles of pipeline and permanent gravel roads. Upcoming oil development projects considered in the cumulative effects analysis are:

- Development of GMT1 (construction began winter 2016-2017)
- Nanushuk development is currently under analysis through an EIS led by the U.S. Army Corps of Engineers. Oil Search Alaska, LLC assumed the role of Operator for the Nanushuk development in March 2018, and the schedule for the EIS has been extended. The former Operator (Armstrong) expected the first development in the Pikka Unit to go online no later than 2022.
- Future development of the Bear Tooth Unit
- Future development of the Willow Prospect

A.2.5.1 Evaluation of the Effect of Such Use, Occupancy, or Disposition on Subsistence Uses and Needs

Cumulative effects on subsistence would be similar if Alternatives A or B are selected in the ROD for GMT2. If Alternative C is selected, cumulative effects would differ due to the lack of an access road. Construction of GMT2 without a road would reduce the likelihood of local displacement of caribou, but would not include facilitated subsistence access via the road and would substantially increase aircraft traffic in the GMT2 area.

GMT2 SEIS § 4.6.8.8 indicates that, irrespective of the GMT2 alternative selected, cumulative activity in the Nuiqsut subsistence use area will increasingly restrict subsistence access and decrease the availability of caribou in traditional use areas. This analysis focuses in part on the impacts that would be associated with an access road to GMT2 (Alternatives A and B) and assumes access roads to any future development west of GMT2. For the roadless scenario (Alternative C), impacts from roads as described below would not accumulate from development of GMT2 and impacts to subsistence hunting success from aircraft traffic (noise, emissions, larger footprint of sites) would accumulate to a greater degree.

The CD5 and GMT1 development projects are present actions most closely connected to the proposed GMT2 project. Development of GMT1 was dependent upon the construction and operation of CD5;

likewise development of GMT2 is dependent on GMT1. CD5 is located directly west of the Nigliq Channel (approximately 8 miles north of Nuiqsut) and connects via a bridge and pipeline to the Alpine field in the Colville Delta (Fig. 4).

Development of GMT2 would, with existing development in the Colville Delta and west of the Colville (CD5 and GMT1), as well as the reasonably foreseeable development in the Bear Tooth Unit/Willow Prospect, bound Nuiqsut by development to the north, northwest, west, and southwest (Fig. 4). Exploratory drilling (Stony Hill, Horseshoe) and seismic surveys (Bear survey) are currently occurring south of Nuiqsut. Recently acquired leases west and southwest of Nuiqsut, including 595,000 additional acres leased by the applicant in 2016, strongly indicate the likelihood of oil exploration and, depending on the results of that exploration, development infrastructure to the south/southwest of Nuiqsut as well.

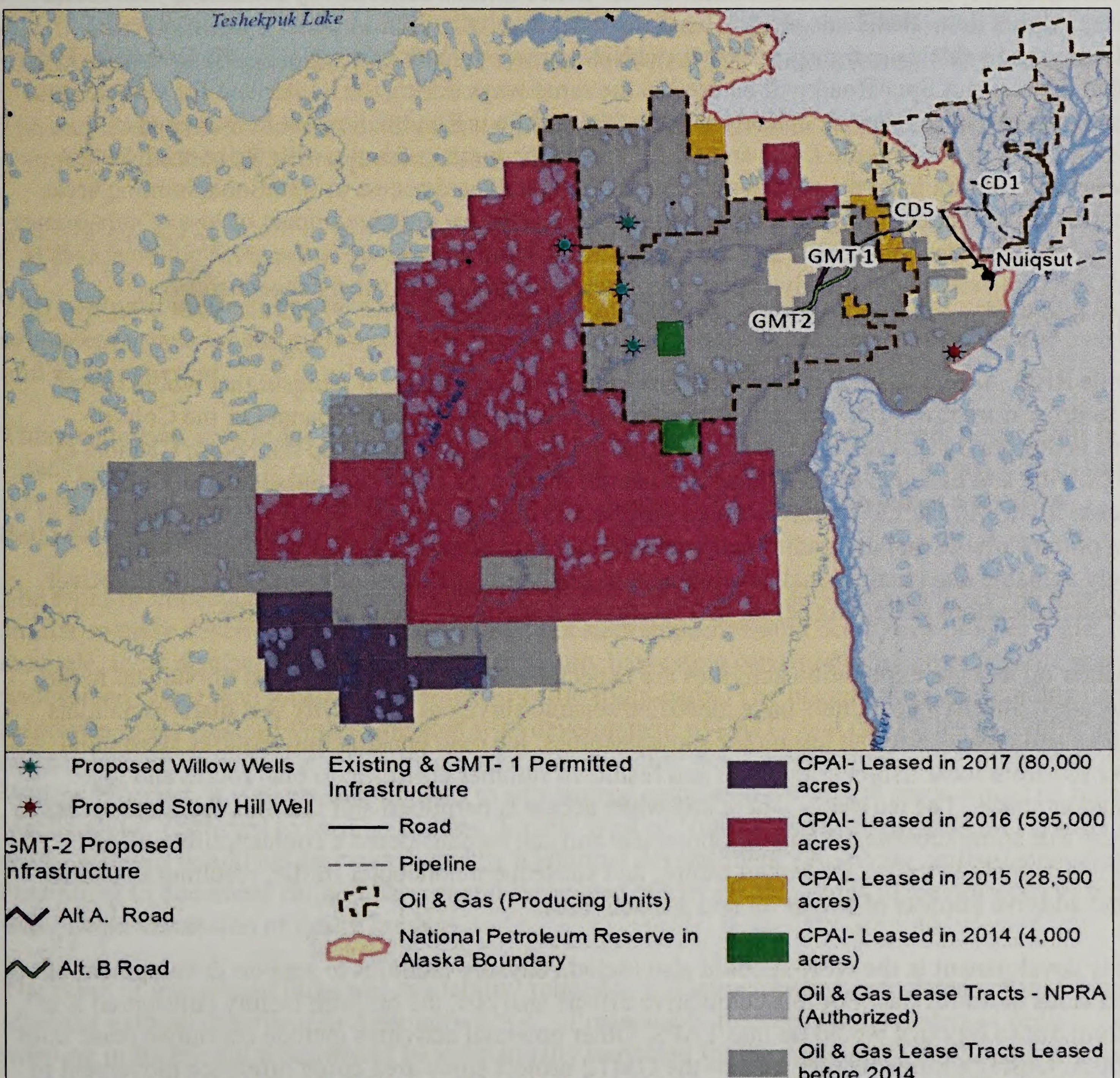

Figure 4. Existing and projected development near Nuiqsut

GMT2 scoping comments submitted by the Kuukpik Corporation include a recitation of the comments that the Nuiqsut village ANCSA corporation submitted in response to the 2012 Draft NPR-A IAP/EIS

regarding development that has "*choked Nuiqsut's Inupiat residents off from our traditional lands*," (J. Nukapigak and Kuukpik Corp., 2016).

> *"We are not feeling boxed in – we are boxed in, or soon will be as CD5, GMT1, and GMT2 are built to the west and southwest, in addition to the existing developments to the north (Alpine), northeast (Ooguruk and Nikaitchuq), east (Kuparuk and Prudhoe Bay) and southeast (Tarn and Meltwater). With physical barriers existing or proposed on three sides of our community, being boxed in is not just a perception – it is a reality."*

The Kuukpik Spur Road was constructed in 2016. The Kuukpik Corporation proposed the road in order to increase user access to hunting areas in the Colville Delta, CD5, and GMTU areas. The Spur Road supports Kuukpik Corporation and its subsidiaries' oil-field business activities by providing year-round access to the Alpine field. Residents already use ice roads seasonally with motorized vehicles and commonly use road vehicles to transport snowmachines to more remote hunting areas via ice roads. Data indicate that the Nuiqsut Spur Road will be used in the same ways during the winter and for vehicles and ORVs during the rest of the year. It is likely that the Nuiqsut Spur Road will result in increased subsistence hunting in the Colville Delta and GMTU areas for some residents, with the restriction that ATV access to the tundra from the road is prohibited. This facilitated access to traditional hunting areas can be considered a countervailing effect that partially mitigates the negative impact of loss of subsistence use areas by industrial development. The road may increase hunting pressure in the areas where access is facilitated, and these areas could likely experience greater disturbance to subsistence resources, particularly caribou, due to industrial activity and traffic on the road.

The Colville River Access Road is a road proposed by the Native Village of Nuiqsut that would allow residents to drive from town to a boat launch area south of town on the main channel of the Colville River. This is desirable because otherwise subsistence boating requires travel up the Niqliq Channel to reach the Colville and that area of the Niqliq is often too shallow to allow safe passage. The Colville River Access Road will facilitate boat access to upriver and downriver areas of the Colville including to tributaries of the Colville that are traditionally valuable for subsistence, and that will likely become increasingly valuable due to additional development to the North and West of town. The Colville River Access Road is therefore mitigating action that facilitates subsistence use of the Colville.

Annual winter oil and gas exploration activities are expected to continue in areas west of Nuiqsut in the coming decades. Subsistence hunters have identified seismic survey as an activity that disturbs animals from the area and creates difficult terrain for snowmachines. Ice road construction requires substantial fresh water use from local fish-bearing lakes and results in summer air traffic to plan routes and to retrieve marker stakes. The ice roads, where and when access is permitted and feasible, facilitate access to remote areas that some subsistence hunters appreciate and can be considered a countervailing effect. Adverse impacts include traffic, large man camps, and subsequent helicopter traffic, resulting in overall adverse and additive impacts of winter oil and gas activities.

Foreseeable development in the NPR-A could also include onshore facilities to support development of submerged lands in Smith Bay. For this cumulative effects analysis, the onshore facility considered is a pipeline from Smith Bay that would tie into TAPS. Other potential activities include continued lease sales in the NPR-A. Onshore infrastructure west of the GMT2 project study area could influence movement of the TCH. The onshore support infrastructure for offshore activities could make it more economically viable to extract oil and gas reserves from a wide area spanning the NPR-A in which oil and gas would otherwise not be economically recoverable. Infrastructure built for coastal onshore oil and gas activities could encourage offshore development. This could cause a synergistic increase in disturbance sources. There is the potential for this scenario to have a significant impact on subsistence resources and access to those resources for the communities of Utqiagvik, Atqasuk, Anaktuvuk Pass, and Nuiqsut.

The cumulative effects of these current and future activities on restricting access to traditional subsistence use areas and to resource distribution and abundance are likely to be long-term, lasting as long as the life of the onshore and offshore oil fields. Any reduction in the calving and summer habitat use by caribou cows and calves from future onshore development would represent a functional loss of habitat that could result in long-term effects on the caribou herds' productivity and abundance.

A.2.5.2 Evaluation of the Availability of Other Lands

The cumulative case is based on adoption of GMT2 Alternative A, thus this evaluation is identical to that provided above in § A.2.1.2.

A.2.5.3 Evaluation of Other Alternatives that would Reduce or Eliminate the Use, Occupancy, or Disposition of Public Lands Needed for Subsistence Purposes

The cumulative case is based on adoption of GMT2 Alternative A, thus the evaluation of other alternatives is identical to that provided above in § A.2.1.3.

A.2.5.4 Findings

This evaluation concludes that the Cumulative Case may result in a significant restriction to subsistence uses for the community of Nuiqsut due to impacts to caribou and furbearer availability and access thereof.

This evaluation concludes that the Cumulative Case may result in a significant restriction to subsistence uses for the communities of Utqiagvik, Atqasuk, and Anaktuvuk Pass due to impacts to terrestrial and marine subsistence resources and access. This finding requires a positive determination pursuant to ANILCA § 810.

The types of impacts on caribou availability related to infrastructure and associated activity would be similar to those described in Alternatives A-C, but such impacts would occur on a broader scale. For example, local displacement and increased difficulty harvesting caribou due to aircraft traffic may be widespread rather than localized in project-specific flight paths. The uncertainties surrounding caribou responses to the road network associated with development of GMT1 and GMT2 make it difficult to assess changes to caribou availability associated with future development such as development of the Willow Prospect. It is likely that impacts to subsistence associated with these roads would be highly localized (i.e. restricted to caribou hunting directly west of Nuiqsut and south of the GMT1-GMT2 access road), and thus would not be exacerbated by additional development. Observing caribou movements and continuing to document caribou harvest and associated hunter effort metrics in the presence of these roads will inform discussion of future impacts.

The types of impacts on furbearer availability related to infrastructure and associated activity would be identical to those described in Alternatives A-C. If reasonably foreseeable development occurs, furbearer trapping in traditional areas would be substantially impacted for the duration of development activities, and would thus constitute a substantial effect on subsistence users' ability to harvest these resources.

Foreseeable development in the NPR-A includes onshore facilities to support development of submerged lands in Smith Bay and additional lease sales and development in the NPR-A. This synergistic increase in disturbance sources could have a significant impact on subsistence resource availability and access to those resources for the communities of Utqiagvik, Atqasuk, and Anaktuvuk Pass, as foreseeable

developments such as these would likely be located within subsistence use areas of these communities. Similar to GMT1 and GMT2, it is likely that these impacts would be unique to the location and specific design features of each project. Procedures would be in place to ensure that future development affects access to subsistence resources as little as possible, and development would facilitate access when possible via use of development infrastructure (e.g. roads), but it is likely that safety considerations would reduce the total area available for subsistence purposes. If reasonably foreseeable development occurs, there could be a substantial effect on subsistence users' ability to access subsistence use areas, or access new or less-frequently used areas that become more important in light of development.

A.3 Notice and Hearings

ANILCA § 810(a) provides that no "withdrawal, reservation, lease, permit, or other use, occupancy or disposition of the public lands which would significantly restrict subsistence uses shall be effected" until the federal agency gives the required notice and holds hearings in accordance with ANILCA § 810(a)(1) and (2). The BLM provided notice in the Federal Register that it made positive findings pursuant to ANILCA § 810 that alternatives A, B, and C and the cumulative case presented in the GMT2 SEIS, met the "may significantly restrict" threshold. As a result, public hearings were held in the potentially affected communities of Nuiqsut, Utqiagvik, Atqasuk, and Anaktuvuk Pass. Notice of these hearings were provided in the Federal Register and by way of the local media, including the Arctic Sounder newspaper, and KBRW, the local Utqiagvik radio station with coverage to all villages on the North Slope. Meeting dates and times were posted on BLM's website at *www.blm.gov/ak/gmt.*

A.4 Subsistence Determinations under ANILCA § 810(a)(3)(A), (B), & (C)

ANILCA § 810(a) provides that no "withdrawal, reservation, lease, permit, or other use, occupancy or disposition of the public lands which would significantly restrict subsistence uses shall be effected" until the federal agency gives the required notice and holds hearings in accordance with ANILCA §810(a)(1) and (2), and makes the three determinations required by ANILCA § 810(a)(3)(A), (B), and (C). The three determinations that must be made are:

1) Such a significant restriction of subsistence use is necessary, consistent with sound management principles for the utilization of the public lands;

2) The proposed activity will involve the minimal amount of public lands necessary to accomplish the purposes of such use, occupancy, or other such disposition; and,

3) Reasonable steps will be taken to minimize adverse impacts to subsistence uses and resources resulting from such actions [16 U.S.C. § 3120(a)(3)(A), (B), and (C)].

The BLM found that Alternatives A, B, and C and the cumulative case considered in the GMT2 SEIS may significantly restrict subsistence uses. Therefore, the BLM undertook the notice and hearing procedures required by ANILCA § 810 (a)(1) and (2) in conjunction with release of the Draft GMT2 SEIS in order to solicit public comment from the potentially affected communities and subsistence users.

The determinations below satisfy the requirements of ANILCA § 810(a)(3)(A), (B), and (C).

A.4.1. Significant restriction of subsistence use is necessary, consistent with sound management principles for the utilization of public lands

BLM drafted the GMT2 SEIS in response to ConocoPhillips' applications to develop and produce oil from leases in the GMTU, and to fulfill BLM's responsibilities to manage these lands under authority of the NPRPA and Federal Land Policy and Management Act (FLPMA) while providing protections for specific habitats and site-specific resources and uses identified and developed through a NEPA process. The SEIS will provide the opportunity, subject to appropriate conditions, to construct the necessary infrastructure to produce oil from the GMTU.

The BLM considered multiple factors with regard to the proposed activity on public lands, including the comments received during the public meetings and hearings which stressed the importance of facilitating Nuiqsut residents' continued use of the project area and local preferences for development scenarios that contribute the lowest increase in aircraft traffic.The BLM determined that Alternative A best fulfills the purpose and need of the proposed action, while incorporating protective measures that serve to minimize impacts to important subsistence resources and use areas. Alternative A considers the necessity for economically feasible development while providing protections to minimize impacts to subsistence resources and uses. Under Alternative A, the lease stipulations and BMPs that accompany the alternative would be the primary mitigation measures to reduce the impact of the proposed action on subsistence uses and resources.

The BLM determined that the significant restriction that may occur under Alternative A, when considered with all possible impacts of the cumulative case, is necessary, consistent with sound management principles for the use of these public lands, and for BLM to fulfill the management goals of the NPR-A as directed by the 2013 NPR-A IAP/EIS, the NPRPA, and FLPMA.

A.4.2. The proposed activitiy will involve the minimal amount of public lands necessary to accomplish the purpose of such use, occupancy, or other disposition

The BLM analyzed four alternatives. Alternative D (No Action) would involve the minimal amount of public lands necessary, but it would not accomplish the purpose of the proposed action, nor would it fulfill the management goals of the NPR-A as directed by the 2013 NPR-A IAP/EIS, the NPRPA, or FLPMA. The federal lands that would be impacted are the same under Alternatives A, B, and C, although physical footprints of each would vary. Alternative C would involve the minimal amount of public lands necessary to accomplish the purpose of the proposed action, but it would not meet the requirement outlined in A.4.3. Alternative A would involve the minimal amount of public lands necessary to accomplish the purposes of the proposed action given that Alternative C does not qualify. Under Alternative B, the GMT1-GMT2 access road would be 1.8 miles longer than the road proposed under Alternative A. Therefore, alternative B would not involve the minimal amount of public lands necessary to accomplish the proposed action.

Other lands managed by the BLM are too distant to access the GMTU reservoir using current drilling technologies. Consideration of other lands, therefore, would not accomplish the purpose of the proposed action.

A.4.3. Reasonable steps will be taken to minimize adverse impacts upon subsistence uses and resouces resulting from such actions

The information acquired through analysis of impacts to subsistence, insight from public meetings and ANILCA § 810 hearings, meetings with the NPR-A Subsistence Advisory Panel, and consultation with tribal and local governments were used to analyze the impacts of Alternatives A, B, C, and D. Several existing mitigation measures would minimize adverse impacts to subsistence. In addition, ConocoPhillips proposes implementing various voluntary policies and measures which will further minimize impacts to subsistence. These stipulations, BMPs, and efforts are summarized herein, but are described, in detail, in GMT2 SEIS § 4.3.4.1, and 4.4.5.6, and Appendix J.

Existing stipulations and BMPs from the 2013 NPR-A IAP/EIS ROD that address subsistence include:

Measures to ensure the continued health of wildlife, fish, and subsistence resources

Many of the measures established in the 2013 NPR-A IAP/EIS ROD are intended to ensure the continued health of fish, wildlife, and subsistence resources. Measures to mitigate impacts to fish are described in GMT2 SEIS § 4.3.2, those addressing impacts to birds are described in § 4.3.3, and those addressing impacts to mammals are described in § 4.3.4. Mitigation measures addressing impacts to water resources and vegetation are described in § 4.2.2 and 4.3.1 respectively.

Measures to avoid conflict with subsistence users

- E-1: All roads must be designed, constructed, maintained, and operated to create minimal environmental impacts and to protect subsistence use and access to subsistence hunting and fishing areas.
- E-2: Permanent oil and gas facilities, including roads, airstrips, and pipelines, are prohibited upon or within 500 feet of fish-bearing water bodies.
- E-3: Causways and docks are prohibited in river mouths or deltas. Artificial gravel islands and bottom-founded structures are prohibited in river mouths, active stream channels, or river deltas
- E-7: Pipelines and roads shall be designed to allow the free movement of caribou and the safe, unimpeded passage of the public while participating in subsistence activities
- F-1: Permittee will ensure that aircraft used for permitted activities comply with the guidelines outlined therin
- H-1: Permittee will consult directly with affected communities using the guidelines outlined therein
- H-2: Permittee will notify the local search and rescue organizations of proposed seismic survey locations for that operation season, and will comply with the guidelines therein

- H-3: Hunting and trapping by the permittee's employees, agents, and contractors are prohibited when persons are on "work status"
- I-1: All personnel involved in oil and gas and related activities shall be provided information concerning applicable stipulations, BMPs, standards, and specific types of environmental, social, traditional, and cultural concerns that relate to the region. The permittee shall ensure that all personnel involved in permitted activities shall attend an orientation program at least once a year and will consist of the guidelines therein

ConocoPhillips has implemented voluntary policies and measures to address impacts to subsistence under previous authorizations, and proposes similar policies during development and operation of the GMT2 site. These include incorporating vehicle pullouts into the design of the GMT1-GMT2 access road, which would facilitate egress from the road and access to lands west of Nuiqsut. ConocoPhillips consistently attempts to coordinate aircraft operations both internally and with other regional oil development companies, and to minimize flights when possible, specifically during peak hunting season.

Given that these lease stipulations, BMPs, and voluntary policies directly protect or address subsistence resources and concerns, the BLM determines that any roaded alternative (i.e., Alternatives A or B) will include reasonable steps to minimize impacts upon subsistence uses and resources.

A.4.4. Concluding Declaration

The BLM has determined that, after consideration of all alternatives, subsistence evaluations, and public hearings, such a significant restriction of subsistence uses is necessary, consistent with sound management principles for the utilization of this land, and that the selected alternative will involve the minimal amount of public lands necessary to accomplish Alternative A. Reasonable steps have and will be taken to minimize the adverse impacts upon subsistence uses and resources arising from this action.

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APPENDIX M

CALPUFF SAMPLE FILES FOR FAR FIELD AIR QUALITY MODELING

APPENDIX M

Sample Files for Far-Field Air Quality Modeling

1. Sample CALPUFF Input File

```
Greater Mooses Tooth 2, Alt A CALPUFF run, 141x100x4.000km mesh, 2009
4.000km WRF supplied by BOEM.
Using MMIF, not CALMET.  Hourly ozone, 1 ppb NH3.
No gridded receptors, only sensitive Class II receptors.
---------------- Run title (3 lines) ----------------------------------------
-----

                    CALPUFF MODEL CONTROL FILE
                    --------------------------

---------------------------------------------------------------------------
-----

INPUT GROUP: 0 -- Input and Output File Names

--------------
Default Name  Type          File Name
------------  ----          ---------
CALMET.DAT    input    * METDAT =           *
    or
ISCMET.DAT    input    * ISCDAT =           *
    or
PLMMET.DAT    input    * PLMDAT =           *
    or
PROFILE.DAT   input    * PRFDAT =           *
SURFACE.DAT   input    * SFCDAT =           *
RESTARTB.DAT  input    * RSTARTB=           *
---------------------------------------------------------------------------
------
CALPUFF.LST   output   ! PUFLST = gmt2.2009.out   !
CONC.DAT      output   ! CONDAT = gmt2.2009.con   !
DFLX.DAT      output   ! DFDAT  = gmt2.2009.dry   !
WFLX.DAT      output   ! WFDAT  = gmt2.2009.wet   !

VISB.DAT      output   * VISDAT =           *
TK2D.DAT      output   * T2DDAT =           *
RHO2D.DAT     output   * RHODAT =           *
RESTARTE.DAT  output   * RSTARTE=           *
---------------------------------------------------------------------------
------
Emission Files
--------------
PTEMARB.DAT   input    * PTDAT  =           *
VOLEMARB.DAT  input    * VOLDAT =           *
BAEMARB.DAT   input    * ARDAT  =           *
LNEMARB.DAT   input    * LNDAT  =           *
---------------------------------------------------------------------------
------
Other Files
```

```
-----------
OZONE.DAT       input     ! OZDAT   = ozone/ozone.nuiqsut.2009-2013.dat !
VD.DAT          input     * VDDAT   =                    *
CHEM.DAT        input     * CHEMDAT=                     *
H2O2.DAT        input     * H2O2DAT=                     *
HILL.DAT        input     * HILDAT=                      *
HILLRCT.DAT     input     * RCTDAT=                      *
COASTLN.DAT     input     * CSTDAT=                      *
FLUXBDY.DAT     input     * BDYDAT=                      *
BCON.DAT        input     * BCNDAT=                      *
DEBUG.DAT       output    * DEBUG =                      *
MASSFLX.DAT     output    * FLXDAT=                      *
MASSBAL.DAT     output    ! BALDAT= gmt2.2009.bal !
FOG.DAT         output    * FOGDAT=                      *
-------------------------------------------------------------------------------
------
All file names will be converted to lower case if LCFILES = T
Otherwise, if LCFILES = F, file names will be converted to UPPER CASE
        T = lower case          ! LCFILES = T !
        F = UPPER CASE
NOTE: (1) file/path names can be up to 70 characters in length


Provision for multiple input files
----------------------------------

     Number of CALMET.DAT files for run (NMETDAT)
                                Default: 1          ! NMETDAT = 12   !

     Number of PTEMARB.DAT files for run (NPTDAT)
                                Default: 0          ! NPTDAT =  0   !

     Number of BAEMARB.DAT files for run (NARDAT)
                                Default: 0          ! NARDAT =  0   !

     Number of VOLEMARB.DAT files for run (NVOLDAT)
                                Default: 0          ! NVOLDAT =  0   !

!END!

-------------
Subgroup (0a)
-------------

  The following CALMET.DAT filenames are processed in sequence if
NMETDAT>1

Default Name  Type     File Name
------------  ----     ---------
CALMET.DAT    input    ! METDAT =../mmif/gmt2.2009.01.met ! !END!
CALMET.DAT    input    ! METDAT =../mmif/gmt2.2009.02.met ! !END!
CALMET.DAT    input    ! METDAT =../mmif/gmt2.2009.03.met ! !END!
CALMET.DAT    input    ! METDAT =../mmif/gmt2.2009.04.met ! !END!
CALMET.DAT    input    ! METDAT =../mmif/gmt2.2009.05.met ! !END!
```

```
CALMET.DAT     input    ! METDAT =../mmif/gmt2.2009.06.met ! !END!
CALMET.DAT     input    ! METDAT =../mmif/gmt2.2009.07.met ! !END!
CALMET.DAT     input    ! METDAT =../mmif/gmt2.2009.08.met ! !END!
CALMET.DAT     input    ! METDAT =../mmif/gmt2.2009.09.met ! !END!
CALMET.DAT     input    ! METDAT =../mmif/gmt2.2009.10.met ! !END!
CALMET.DAT     input    ! METDAT =../mmif/gmt2.2009.11.met ! !END!
CALMET.DAT     input    ! METDAT =../mmif/gmt2.2009.12.met ! !END!

------------------------------------------------------------------------------
------

INPUT GROUP: 1 -- General run control parameters
--------------

    Option to run all periods found
    in the met. file     (METRUN)   Default: 0        ! METRUN =   0  !

         METRUN = 0 - Run period explicitly defined below
         METRUN = 1 - Run all periods in met. file

     Starting date:   Year (IBYR) -- No default        ! IBYR =  2009 !
     (used only if   Month (IBMO) -- No default        ! IBMO =  01   !
      METRUN = 0)      Day (IBDY) -- No default        ! IBDY =  01   !
                      Hour (IBHR) -- No default        ! IBHR =  01   !

     Base time zone         (XBTZ) -- No default        ! XBTZ = 9.0   !
        PST = 8., MST = 7.
        CST = 6., EST = 5.

     Length of run (hours) (IRLG) -- No default        ! IRLG =  8760 !

     Number of chemical species (NSPEC)
                                  Default: 5        ! NSPEC = 13   ! 9+4

     Number of chemical species
     to be emitted  (NSE)         Default: 3        ! NSE   =  9   !

     Flag to stop run after
     SETUP phase (ITEST)          Default: 2        ! ITEST =  2   !
     (Used to allow checking
     of the model inputs, files, etc.)
           ITEST = 1 - STOPS program after SETUP phase
           ITEST = 2 - Continues with execution of program
                       after SETUP

     Restart Configuration:

        Control flag (MRESTART)      Default: 0        ! MRESTART =  0   !

           0 = Do not read or write a restart file
           1 = Read a restart file at the beginning of
               the run
           2 = Write a restart file during run
           3 = Read a restart file at beginning of run
```

```
             and write a restart file during run

     Number of periods in Restart
     output cycle (NRESPD)          Default: 0        ! NRESPD =   0    !

        0 = File written only at last period
       >0 = File updated every NRESPD periods

  Meteorological Data Format (METFM)
                                    Default: 1        ! METFM =  1    !

        METFM = 1 - CALMET binary file (CALMET.MET)
        METFM = 2 - ISC ASCII file (ISCMET.MET)
        METFM = 3 - AUSPLUME ASCII file (PLMMET.MET)
        METFM = 4 - CTDM plus tower file (PROFILE.DAT) and
                    surface parameters file (SURFACE.DAT)
        METFM = 5 - AERMET tower file (PROFILE.DAT) and
                    surface parameters file (SURFACE.DAT)

  Meteorological Profile Data Format (MPRFFM)
       (used only for METFM = 1, 2, 3)
                                    Default: 1        ! MPRFFM =  1  !

        MPRFFM = 1 - CTDM plus tower file (PROFILE.DAT)
        MPRFFM = 2 - AERMET tower file (PROFILE.DAT)


  PG sigma-y is adjusted by the factor (AVET/PGTIME)**0.2
  Averaging Time (minutes) (AVET)
                                    Default: 60.0     ! AVET = 60. !
  PG Averaging Time (minutes) (PGTIME)
                                    Default: 60.0     ! PGTIME = 60. !


!END!


--------------------------------------------------------------------------
-----

INPUT GROUP: 2 -- Technical options
--------------


  Vertical distribution used in the
  near field (MGAUSS)                    Default: 1     ! MGAUSS =  1
!
     0 = uniform
     1 = Gaussian

  Terrain adjustment method
  (MCTADJ)                               Default: 3     ! MCTADJ =  3
!
     0 = no adjustment
```

```
    1 = ISC-type of terrain adjustment
    2 = simple, CALPUFF-type of terrain
        adjustment
    3 = partial plume path adjustment

 Subgrid-scale complex terrain
 flag (MCTSG)                        Default: 0      ! MCTSG =  0   !
    0 = not modeled
    1 = modeled

 Near-field puffs modeled as
 elongated 0 (MSLUG)                 Default: 0      ! MSLUG =  0   !
    0 = no
    1 = yes (slug model used)

 Transitional plume rise modeled ?
 (MTRANS)                            Default: 1      ! MTRANS =  1
!
    0 = no  (i.e., final rise only)
    1 = yes (i.e., transitional rise computed)

 Stack tip downwash? (MTIP)          Default: 1      ! MTIP =  1  !
    0 = no  (i.e., no stack tip downwash)
    1 = yes (i.e., use stack tip downwash)

 Method used to simulate building
 downwash? (MBDW)                    Default: 1      ! MBDW =  1   !
    1 = ISC method
    2 = PRIME method

 Vertical wind shear modeled above
 stack top? (MSHEAR)                 Default: 0      ! MSHEAR =  0  !
    0 = no  (i.e., vertical wind shear not modeled)
    1 = yes (i.e., vertical wind shear modeled)

 Puff splitting allowed? (MSPLIT)    Default: 0      ! MSPLIT =  0  !
    0 = no (i.e., puffs not split)
    1 = yes (i.e., puffs are split)

 Chemical mechanism flag (MCHEM)     Default: 1      ! MCHEM =  1   !
    0 = chemical transformation not modeled
    1 = transformation rates computed internally (MESOPUFF II scheme)
    2 = user-specified transformation rates used
    3 = transformation rates computed internally (RIVAD/ARM3 scheme)
    4 = secondary organic aerosol formation computed (MESOPUFF II
scheme for OH)

 Aqueous phase transformation flag (MAQCHEM)
 (Used only if MCHEM = 1, or 3)      Default: 0      ! MAQCHEM =  0
!
    0 = aqueous phase transformation not modeled
    1 = transformation rates adjusted for aqueous phase reactions

 Wet removal modeled ? (MWET)        Default: 1      ! MWET =  1   !
```

```
      0 = no
      1 = yes

   Dry deposition modeled ? (MDRY)          Default: 1      ! MDRY =  1    !
      0 = no
      1 = yes
      (dry deposition method specified for each species in Input Group
3)

   Gravitational settling (plume tilt)
   modeled ? (MTILT)                        Default: 0      ! MTILT =  0    !
      0 = no
      1 = yes
      (puff center falls at the gravitational
       settling velocity for 1 particle species)

       Restrictions:
       - MDRY   = 1
       - NSPEC  = 1   (must be particle species as well)
       - sg     = 0   GEOMETRIC STANDARD DEVIATION in Group 8 is
                      set to zero for a single particle diameter

   Method used to compute dispersion
   coefficients (MDISP)                     Default: 3      ! MDISP =  3    !

      1 = dispersion coefficients computed from measured values
          of turbulence, sigma v, sigma w
      2 = dispersion coefficients from internally calculated
          sigma v, sigma w using micrometeorological variables
          (u*, w*, L, etc.)
      3 = PG dispersion coefficients for RURAL areas (computed using
          the ISCST multi-segment approximation) and MP coefficients in
          urban areas
      4 = same as 3 except PG coefficients computed using
          the MESOPUFF II eqns.
      5 = CTDM sigmas used for stable and neutral conditions.
          For unstable conditions, sigmas are computed as in
          MDISP = 3, described above.  MDISP = 5 assumes that
          measured values are read

   Sigma-v/sigma-theta, sigma-w measurements used? (MTURBVW)
   (Used only if MDISP = 1 or 5)            Default: 3      ! MTURBVW =  3
!
      1 = use sigma-v or sigma-theta measurements
          from PROFILE.DAT to compute sigma-y
          (valid for METFM = 1, 2, 3, 4, 5)
      2 = use sigma-w measurements
          from PROFILE.DAT to compute sigma-z
          (valid for METFM = 1, 2, 3, 4, 5)
      3 = use both sigma-(v/theta) and sigma-w
          from PROFILE.DAT to compute sigma-y and sigma-z
          (valid for METFM = 1, 2, 3, 4, 5)
      4 = use sigma-theta measurements
          from PLMMET.DAT to compute sigma-y
```

```
       (valid only if METFM = 3)

     Back-up method used to compute dispersion
     when measured turbulence data are
     missing (MDISP2)                       Default: 3     ! MDISP2 =  3  !
     (used only if MDISP = 1 or 5)
        2 = dispersion coefficients from internally calculated
            sigma v, sigma w using micrometeorological variables
            (u*, w*, L, etc.)
        3 = PG dispersion coefficients for RURAL areas (computed using
            the ISCST multi-segment approximation) and MP coefficients in
            urban areas
        4 = same as 3 except PG coefficients computed using
            the MESOPUFF II eqns.

     [DIAGNOSTIC FEATURE]
     Method used for Lagrangian timescale for Sigma-y
     (used only if MDISP=1,2 or MDISP2=1,2)
     (MTAULY)                               Default: 0     ! MTAULY =  0
!
        0 = Draxler default 617.284 (s)
        1 = Computed as Lag. Length / (.75 q) -- after SCIPUFF
       10 < Direct user input (s)             -- e.g., 306.9


     [DIAGNOSTIC FEATURE]
     Method used for Advective-Decay timescale for Turbulence
     (used only if MDISP=2 or MDISP2=2)
     (MTAUADV)                              Default: 0     ! MTAUADV =  0
!
        0 = No turbulence advection
        1 = Computed (OPTION NOT IMPLEMENTED)
       10 < Direct user input (s)   -- e.g., 800


     Method used to compute turbulence sigma-v &
     sigma-w using micrometeorological variables
     (Used only if MDISP = 2 or MDISP2 = 2)
     (MCTURB)                               Default: 1     ! MCTURB =  1
!
        1 = Standard CALPUFF subroutines
        2 = AERMOD subroutines

     PG sigma-y,z adj. for roughness?       Default: 0     ! MROUGH =  0  !
     (MROUGH)
        0 = no
        1 = yes

     Partial plume penetration of           Default: 1     ! MPARTL =  1  !
     elevated inversion?
     (MPARTL)
        0 = no
        1 = yes
```

```
Strength of temperature inversion     Default: 0      ! MTINV =  0  !
provided in PROFILE.DAT extended records?
(MTINV)
   0 = no (computed from measured/default gradients)
   1 = yes

PDF used for dispersion under convective conditions?
                                      Default: 0      ! MPDF =  0  !
(MPDF)
   0 = no
   1 = yes

Sub-Grid TIBL module used for shore line?
                                      Default: 0      ! MSGTIBL = 0  !
(MSGTIBL)
   0 = no
   1 = yes

Boundary conditions (concentration) modeled?
                                      Default: 0      ! MBCON = 0  !
(MBCON)
   0 = no
   1 = yes, using formatted BCON.DAT file
   2 = yes, using unformatted CONC.DAT file

Note:  MBCON > 0 requires that the last species modeled
       be 'BCON'.  Mass is placed in species BCON when
       generating boundary condition puffs so that clean
       air entering the modeling domain can be simulated
       in the same way as polluted air.  Specify zero
       emission of species BCON for all regular sources.


Individual source contributions saved?
                                      Default: 0      ! MSOURCE = 0  !
(MSOURCE)
   0 = no
   1 = yes


Analyses of fogging and icing impacts due to emissions from
arrays of mechanically-forced cooling towers can be performed
using CALPUFF in conjunction with a cooling tower emissions
processor (CTEMISS) and its associated postprocessors.  Hourly
emissions of water vapor and temperature from each cooling tower
cell are computed for the current cell configuration and ambient
conditions by CTEMISS. CALPUFF models the dispersion of these
emissions and provides cloud information in a specialized format
for further analysis. Output to FOG.DAT is provided in either
'plume mode' or 'receptor mode' format.

Configure for FOG Model output?
                                      Default: 0      ! MFOG =  0  !

(MFOG)
```

```
      0 = no
      1 = yes  - report results in PLUME Mode format
      2 = yes  - report results in RECEPTOR Mode format


  Test options specified to see if
  they conform to regulatory
  values? (MREG)                          Default: 1     ! MREG =  1   !

      0 = NO checks are made
      1 = Technical options must conform to USEPA
          Long Range Transport (LRT) guidance
                     METFM    1 or 2
                     AVET     60. (min)
                     PGTIME   60. (min)
                     MGAUSS   1
                     MCTADJ   3
                     MTRANS   1
                     MTIP     1
                     MCHEM    1 or 3 (if modeling SOx, NOx)
                     MWET     1
                     MDRY     1
                     MDISP    2 or 3
                     MPDF     0 if MDISP=3
                              1 if MDISP=2
                     MROUGH   0
                     MPARTL   1
                     SYTDEP   550. (m)
                     MHFTSZ   0
                     SVMIN    0.5 (m/s)


!END!


-------------------------------------------------------------------------------
-----

INPUT GROUP: 3a, 3b -- Species list
-------------------

------------
Subgroup (3a)
------------

  The following species are modeled:

! CSPEC =          SO2 !          !END!
! CSPEC =          SO4 !          !END!
! CSPEC =          NOX !          !END!
! CSPEC =         HNO3 !          !END!
! CSPEC =          NO3 !          !END!
! CSPEC =           EC !          !END!
! CSPEC =          SOA !          !END!
```

```
! CSPEC =          PMC !         !END!
! CSPEC =          PMF !         !END!
! CSPEC =         nSO2 !         !END! Non-reactive SO2
! CSPEC =         nNOX !         !END! Non-reactive NOx
! CSPEC =        nPM10 !         !END! Non-reactive PM10
! CSPEC =        nPM25 !         !END! Non-reactive PM2.5

                                                          Dry
OUTPUT GROUP
   SPECIES          MODELED          EMITTED          DEPOSITED
NUMBER
     NAME         (0=NO, 1=YES)    (0=NO, 1=YES)     (0=NO,
(0=NONE,
   (Limit: 12                                         1=COMPUTED-GAS
1=1st CGRUP,
    Characters                                        2=COMPUTED-PARTICLE
2=2nd CGRUP,
    in length)                                        3=USER-SPECIFIED)
3= etc.)

!           SO2  =         1,              1,           1,
0  !
!           SO4  =         1,              1,           2,
0  !
!           NOX  =         1,              1,           1,
0  !
!          HNO3  =         1,              1,           1,
0  !
!           NO3  =         1,              1,           2,
0  !
!            EC  =         1,              1,           2,
0  !
!           SOA  =         1,              1,           2,
0  !
!           PMC  =         1,              1,           2,
0  !
!           PMF  =         1,              1,           2,
0  !
!          nSO2  =         1,              1,           0,
0  !
!          nNOX  =         1,              1,           0,
0  !
!         nPM10  =         1,              1,           0,
0  !
!         nPM25  =         1,              1,           0,
0  !

!END!
```

Note: The last species in (3a) must be 'BCON' when using the boundary condition option (MBCON > 0). Species BCON should typically be modeled as inert (no chem transformation or removal).

```
-------------
Subgroup (3b)
-------------
  The following names are used for Species-Groups in which results
  for certain species are combined (added) prior to output.  The
  CGRUP name will be used as the species name in output files.
  Use this feature to model specific particle-size distributions
  by treating each size-range as a separate species.
  Order must be consistent with 3(a) above.



--------------------------------------------------------------------------------
-----


INPUT GROUP: 4 -- Map Projection and Grid control parameters
--------------

     Projection for all (X,Y):
     -------------------------

     Map projection
     (PMAP)                     Default: UTM    ! PMAP = PS  !

         UTM :  Universal Transverse Mercator
         TTM :  Tangential Transverse Mercator
         LCC :  Lambert Conformal Conic
          PS :  Polar Stereographic
          EM :  Equatorial Mercator
        LAZA :  Lambert Azimuthal Equal Area

     False Easting and Northing (km) at the projection origin
     (Used only if PMAP= TTM, LCC, or LAZA)
     (FEAST)                    Default=0.0     ! FEAST  = 0.000  !
     (FNORTH)                   Default=0.0     ! FNORTH = 0.000  !

     UTM zone (1 to 60)
     (Used only if PMAP=UTM)
     (IUTMZN)                   No Default      ! IUTMZN =   0   !

     Hemisphere for UTM projection?
     (Used only if PMAP=UTM)
     (UTMHEM)                   Default: N      ! UTMHEM = N  !
         N   :  Northern hemisphere projection
         S   :  Southern hemisphere projection

     Latitude and Longitude (decimal degrees) of projection origin
     (Used only if PMAP= TTM, LCC, PS, EM, or LAZA)
     (RLAT0)                    No Default      ! RLAT0 = 70.000N !
     (RLON0)                    No Default      ! RLON0 = 155.000W !

         TTM :  RLON0 identifies central (true N/S) meridian of projection
```

```
                RLAT0 selected for convenience
         LCC :  RLON0 identifies central (true N/S) meridian of projection
                RLAT0 selected for convenience
         PS  :  RLON0 identifies central (grid N/S) meridian of projection
                RLAT0 selected for convenience
         EM  :  RLON0 identifies central meridian of projection
                RLAT0 is REPLACED by 0.0N (Equator)
         LAZA:  RLON0 identifies longitude of tangent-point of mapping
plane
                RLAT0 identifies latitude of tangent-point of mapping
plane

     Matching parallel(s) of latitude (decimal degrees) for projection
     (Used only if PMAP= LCC or PS)
     (XLAT1)                    No Default      ! XLAT1 = 70.000N !
     (XLAT2)                    No Default      ! XLAT2 = 70.000N !

         LCC :  Projection cone slices through Earth's surface at XLAT1
and XLAT2
         PS  :  Projection plane slices through Earth at XLAT1
                (XLAT2 is not used)

     ----------
     Note:  Latitudes and longitudes should be positive, and include a
            letter N,S,E, or W indicating north or south latitude, and
            east or west longitude.  For example,
            35.9  N Latitude  =  35.9N
            118.7 E Longitude = 118.7E


     Datum-region
     ------------

     The Datum-Region for the coordinates is identified by a character
     string.  Many mapping products currently available use the model of
the
     Earth known as the World Geodetic System 1984 (WGS-84).  Other local
     models may be in use, and their selection in CALMET will make its
output
     consistent with local mapping products.  The list of Datum-Regions
with
     official transformation parameters is provided by the National
Imagery and
     Mapping Agency (NIMA).

     NIMA Datum - Regions(Examples)
     ------------------------------------------------------------------------
---------
     WGS-84    WGS-84 Reference Ellipsoid and Geoid, Global coverage
(WGS84)
     NAS-C     NORTH AMERICAN 1927 Clarke 1866 Spheroid, MEAN FOR CONUS
(NAD27)
     NAR-C     NORTH AMERICAN 1983 GRS 80 Spheroid, MEAN FOR CONUS (NAD83)
     NWS-84    NWS 6370KM Radius, Sphere
```

```
ESR-S     ESRI REFERENCE 6371KM Radius, Sphere

Datum-region for output coordinates
(DATUM)                     Default: WGS-G      ! DATUM = NWS-84  !
                                                *** Same as WRF ***


METEOROLOGICAL Grid:

     Rectangular grid defined for projection PMAP,
     with X the Easting and Y the Northing coordinate

            No. X grid cells (NX)      No default      ! NX = 141   !
            No. Y grid cells (NY)      No default      ! NY = 100   !
        No. vertical layers (NZ)       No default      ! NZ =   10  !

           Grid spacing (DGRIDKM)      No default      ! DGRIDKM = 4.000 !
                                       Units: km


                 Cell face heights
                     (ZFACE(nz+1))     No defaults
                                       Units: m
        ! ZFACE =0.,20.,40.,80.,160.,320.,640.,1200.,2000.,3000.,4000.
!

             Reference Coordinates
           of SOUTHWEST corner of
                 grid cell(1, 1):

            X coordinate (XORIGKM)     No default      ! XORIGKM = -130.000
!
            Y coordinate (YORIGKM)     No default      ! YORIGKM = -238.000
!
                                       Units: km


COMPUTATIONAL Grid:

     The computational grid is identical to or a subset of the MET. grid.
     The lower left (LL) corner of the computational grid is at grid point
     (IBCOMP, JBCOMP) of the MET. grid.  The upper right (UR) corner of
the
     computational grid is at grid point (IECOMP, JECOMP) of the MET.
grid.
     The grid spacing of the computational grid is the same as the MET.
grid.

        X index of LL corner (IBCOMP)      No default     ! IBCOMP =  1   !
                 (1 <= IBCOMP <= NX)

        Y index of LL corner (JBCOMP)      No default     ! JBCOMP =  1   !
                 (1 <= JBCOMP <= NY)
```

```
    X index of UR corner (IECOMP)       No default       ! IECOMP = 141 !
              (1 <= IECOMP <= NX)

    Y index of UR corner (JECOMP)       No default       ! JECOMP = 100 !
              (1 <= JECOMP <= NY)


SAMPLING Grid (GRIDDED RECEPTORS):

     The lower left (LL) corner of the sampling grid is at grid point
     (IBSAMP, JBSAMP) of the MET. grid.  The upper right (UR) corner of
the
     sampling grid is at grid point (IESAMP, JESAMP) of the MET. grid.
     The sampling grid must be identical to or a subset of the
computational
     grid.  It may be a nested grid inside the computational grid.
     The grid spacing of the sampling grid is DGRIDKM/MESHDN.

       Logical flag indicating if gridded
       receptors are used (LSAMP)          Default: T       ! LSAMP = F !
       (T=yes, F=no)

       X index of LL corner (IBSAMP)       No default       ! IBSAMP =  1 !
        (IBCOMP <= IBSAMP <= IECOMP)

       Y index of LL corner (JBSAMP)       No default       ! JBSAMP =  1 !
        (JBCOMP <= JBSAMP <= JECOMP)


       X index of UR corner (IESAMP)       No default       ! IESAMP = 141 !
        (IBCOMP <= IESAMP <= IECOMP)

       Y index of UR corner (JESAMP)       No default       ! JESAMP = 100 !
        (JBCOMP <= JESAMP <= JECOMP)


      Nesting factor of the sampling
       grid (MESHDN)                       Default: 1       ! MESHDN =  1  !
       (MESHDN is an integer >= 1)

!END!

--------------------------------------------------------------------------------
-----

INPUT GROUP: 5 -- Output Options
--------------

                                                   *                       *
     FILE                        DEFAULT VALUE              VALUE THIS RUN
     ----                        -------------              --------------
```

```
Concentrations (ICON)                  1                       !  ICON =  1    !
Dry Fluxes (IDRY)                      1                       !  IDRY =  1    !
Wet Fluxes (IWET)                      1                       !  IWET =  1    !
2D Temperature (IT2D)                  0                       !  IT2D =  0    !
2D Density (IRHO)                      0                       !  IRHO =  0    !
Relative Humidity (IVIS)               1                       !  IVIS =  0    !
 (RH file is required for
  VISIBILITY analyses)
Use data compression option in output file?
(LCOMPRS)                               Default: T             ! LCOMPRS = T !

*
 0 = Do not create file, 1 = create file



 QA PLOT FILE OUTPUT OPTION:

    Create a standard series of output files (e.g.
    locations of sources, receptors, grids ...)
    suitable for plotting?
    (IQAPLOT)                           Default: 1             ! IQAPLOT =  1
!
      0 = no
      1 = yes


 DIAGNOSTIC MASS FLUX OUTPUT OPTIONS:

    Mass flux across specified boundaries
    for selected species reported hourly?
    (IMFLX)                             Default: 0             ! IMFLX =  0   !
      0 = no
      1 = yes (FLUXBDY.DAT and MASSFLX.DAT filenames
               are specified in Input Group 0)

    Mass balance for each species
    reported hourly?
    (IMBAL)                             Default: 0             ! IMBAL =  1   !
      0 = no
      1 = yes (MASSBAL.DAT filename is
           specified in Input Group 0)


 LINE PRINTER OUTPUT OPTIONS:

    Print concentrations (ICPRT)        Default: 0             ! ICPRT =  0    !
    Print dry fluxes (IDPRT)            Default: 0             ! IDPRT =  0    !
    Print wet fluxes (IWPRT)            Default: 0             ! IWPRT =  0    !
    (0 = Do not print, 1 = Print)

    Concentration print interval
    (ICFRQ) in hours                    Default: 1             ! ICFRQ =  24
!
```

```
Dry flux print interval
(IDFRQ) in hours                 Default: 1          ! IDFRQ =  1   !
Wet flux print interval
(IWFRQ) in hours                 Default: 1          ! IWFRQ =  1   !

Units for Line Printer Output
(IPRTU)                          Default: 1          ! IPRTU =  1   !
                 for              for
             Concentration      Deposition
    1 =          g/m**3          g/m**2/s
    2 =         mg/m**3         mg/m**2/s
    3 =         ug/m**3         ug/m**2/s
    4 =         ng/m**3         ng/m**2/s
    5 =        Odour Units

Messages tracking progress of run
written to the screen ?
(IMESG)                          Default: 2          ! IMESG =  2   !
  0 = no
  1 = yes (advection step, puff ID)
  2 = yes (2009JJJHH, # old puffs, # emitted puffs)


 SPECIES (or GROUP for combined species) LIST FOR OUTPUT OPTIONS

          ---- CONCENTRATIONS ---- ------ DRY FLUXES ------ ------ WET
FLUXES ------ -- MASS FLUX --
  SPECIES
  /GROUP    PRINTED?  SAVED ON DISK? PRINTED?  SAVED ON DISK? PRINTED?
SAVED ON DISK? SAVED ON DISK?
  -------   ------------------------ ------------------------ -----------
------------- ---------------
!    SO2 =     0,         1,        0,         1,        0,
1,        0  !
!    NOX =     0,         1,        0,         1,        0,
1,        0  !
!   HNO3 =     0,         1,        0,         1,        0,
1,        0  !
!    SO4 =     0,         1,        0,         1,        0,
1,        0  !
!    NO3 =     0,         1,        0,         1,        0,
1,        0  !
!     EC =     0,         1,        0,         1,        0,
1,        0  !
!    SOA =     0,         1,        0,         1,        0,
1,        0  !
!    PMC =     0,         1,        0,         1,        0,
1,        0  !
!    PMF =     0,         1,        0,         1,        0,
1,        0  !
!   nSO2 =     0,         1,        0,         0,        0,
0,        0  !
!   nNOX =     0,         1,        0,         0,        0,
0,        0  !
```

```
!  nPM10 =      0,          1,          0,          0,          0,
0,          0  !
!  nPM25 =      0,          1,          0,          0,          0,
0,          0  !
```

Note: Species BCON (for MBCON > 0) does not need to be saved on disk.

OPTIONS FOR PRINTING "DEBUG" QUANTITIES (much output)

```
     Logical for debug output
     (LDEBUG)                                Default: F      ! LDEBUG =
F !

     First puff to track
     (IPFDEB)                                Default: 1      ! IPFDEB =
1  !

     Number of puffs to track
     (NPFDEB)                                Default: 1      ! NPFDEB =
1  !

     Met. period to start output
     (NN1)                                   Default: 1      ! NN1 =  1
!

     Met. period to end output
     (NN2)                                   Default: 10     ! NN2 =  10
!

!END!
```


INPUT GROUP: 6a, 6b, & 6c -- Subgrid scale complex terrain inputs
----

Subgroup (6a)

```
     Number of terrain features (NHILL)      Default: 0      ! NHILL =
0   !

     Number of special complex terrain
     receptors  (NCTREC)                     Default: 0      ! NCTREC =
0   !

     Terrain and CTSG Receptor data for
     CTSG hills input in CTDM format ?
```

```
        (MHILL)                                          No Default       ! MHILL =
2    !
         1 = Hill and Receptor data created
             by CTDM processors & read from
             HILL.DAT and HILLRCT.DAT files
         2 = Hill data created by OPTHILL &
             input below in Subgroup (6b);
             Receptor data in Subgroup (6c)

        Factor to convert horizontal dimensions  Default: 1.0    ! XHILL2M =
0. !
        to meters (MHILL=1)

        Factor to convert vertical dimensions    Default: 1.0    ! ZHILL2M =
0. !
        to meters (MHILL=1)

        X-origin of CTDM system relative to      No Default      ! XCTDMKM =
0.0E00 !
        CALPUFF coordinate system, in Kilometers (MHILL=1)

        Y-origin of CTDM system relative to      No Default      ! YCTDMKM =
0.0E00 !
        CALPUFF coordinate system, in Kilometers (MHILL=1)

! END !

---------------
Subgroup (6b)
---------------

                              1 **
       HILL information


HILL          XC        YC       THETAH  ZGRID  RELIEF    EXPO 1    EXPO
2   SCALE 1   SCALE 2   AMAX1    AMAX2
 NO.          (km)      (km)     (deg.)   (m)    (m)       (m)       (m)
(m)        (m)        (m)        (m)
----          ----      ----     ------  -----  ------    ------    -----
-   -------   -------   -----    -----

---------------
Subgroup (6c)
---------------

      COMPLEX TERRAIN RECEPTOR INFORMATION

                         XRCT         YRCT         ZRCT          XHH
                         (km)         (km)          (m)
                        ------        -----        ------         ----


-------------------
```

```
1
     Description of Complex Terrain Variables:
          XC, YC   = Coordinates of center of hill
          THETAH   = Orientation of major axis of hill (clockwise from
                     North)
          ZGRID    = Height of the  0  of the grid above mean sea
                     level
          RELIEF   = Height of the crest of the hill above the grid
elevation
          EXPO 1   = Hill-shape exponent for the major axis
          EXPO 2   = Hill-shape exponent for the major axis
          SCALE 1 = Horizontal length scale along the major axis
          SCALE 2 = Horizontal length scale along the minor axis
          AMAX     = Maximum allowed axis length for the major axis
          BMAX     = Maximum allowed axis length for the major axis

          XRCT, YRCT = Coordinates of the complex terrain receptors
          ZRCT     = Height of the ground (MSL) at the complex terrain
                     Receptor
          XHH      = Hill number associated with each complex terrain
receptor
                     (NOTE: MUST BE ENTERED AS A REAL NUMBER)

   **
     NOTE: DATA for each hill and CTSG receptor are treated as a separate
           input subgroup and therefore must end with an input group
terminator.

---------------------------------------------------------------------------
-----


INPUT GROUP: 7 -- Chemical parameters for dry deposition of gases
--------------

      SPECIES      DIFFUSIVITY      ALPHA STAR      REACTIVITY    MESOPHYLL
RESISTANCE     HENRY'S LAW COEFFICIENT
       NAME          (cm**2/s)
(s/cm)                 (dimensionless)
      -------      -----------      ----------      ----------    ---------
-----------     -----------------------

!          SO2 =      0.1509,         1000.,           8.,              0.,
0.04 !
!          NOX =      0.1656,            1.,           8.,              5.,
3.5 !
!         HNO3 =      0.1628,            1.,          18.,              0.,
0.00000008 !

!END!


---------------------------------------------------------------------------
-----
```

```
INPUT GROUP: 8 -- Size parameters for dry deposition of particles
--------------

     For SINGLE SPECIES, the mean and standard deviation are used to
     compute a deposition velocity for NINT (see group 9) size-ranges,
     and these are then averaged to obtain a mean deposition velocity.

     For GROUPED SPECIES, the size distribution should be explicitly
     specified (by the 'species' in the group), and the standard deviation
     for each should be entered as 0.  The model will then use the
     deposition velocity for the stated mean diameter.

      SPECIES        GEOMETRIC MASS MEAN        GEOMETRIC STANDARD
       NAME               DIAMETER                   DEVIATION
                          (microns)                  (microns)
      -------        --------------------       ------------------
 !         SO4 =          0.48,                    2.0  !
 !         NO3 =          0.48,                    2.0  !
 !          EC =          0.48,                    2.0  !
 !         SOA =          0.48,                    2.0  !
 !         PMC =           5.0,                    1.5  !
 !         PMF =          0.48,                    2.0  !

 !END!

 --------------------------------------------------------------------------------
 -----

 INPUT GROUP: 9 -- Miscellaneous dry deposition parameters
 ---------------

      Reference cuticle resistance (s/cm)
      (RCUTR)                                Default: 30    !  RCUTR = 30.0 !
      Reference ground resistance  (s/cm)
      (RGR)                                  Default: 10    !    RGR = 10.0 !
      Reference pollutant reactivity
      (REACTR)                               Default: 8     ! REACTR = 8.0 !

      Number of particle-size intervals used to
      evaluate effective particle deposition velocity
      (NINT)                                 Default: 9     !   NINT =  9   !

      Vegetation state in unirrigated areas
      (IVEG)                                 Default: 1     !   IVEG =  1    !
         IVEG=1 for active and unstressed vegetation
         IVEG=2 for active and stressed vegetation
         IVEG=3 for inactive vegetation

  !END!
```

```
--------------------------------------------------------------------------------
-----

INPUT GROUP: 10 -- Wet Deposition Parameters
---------------

                       Scavenging Coefficient -- Units: (sec)**(-1)

       Pollutant      Liquid Precip.       Frozen Precip.
       ---------      --------------       --------------
!          SO2 =         3.0E-05,             0.0E00 !
!          SO4 =         1.0E-04,            3.0E-05 !
!          NOX =          0.0E00,             0.0E00 !
!         HNO3 =         6.0E-05,             0.0E00 !
!          NO3 =         1.0E-04,            3.0E-05 !
!           EC =         1.0E-04,            3.0E-05 !
!          SOA =         1.0E-04,            3.0E-05 !
!          PMC =         1.0E-04,            3.0E-05 !
!          PMF =         1.0E-04,            3.0E-05 !

!END!

--------------------------------------------------------------------------------
-----

INPUT GROUP: 11 -- Chemistry Parameters
---------------

     Ozone data input option (MOZ)     Default: 1            ! MOZ =  1  !
     (Used only if MCHEM = 1, 3, or 4)
        0 = use a monthly background ozone value
        1 = read hourly ozone concentrations from
            the OZONE.DAT data file

     Monthly ozone concentrations
     (Used only if MCHEM = 1, 3, or 4 and
      MOZ = 0 or MOZ = 1 and all hourly O3 data missing)
     (BCKO3) in ppb                    Default: 12*80.

     !  BCKO3 = 12*59.8 ! ** Highest o3 measured during modeling period,
59.8 ppb on Feb 19 2009 at 17:00 **


     Monthly ammonia concentrations
     (Used only if MCHEM = 1, or 3)
     (BCKNH3) in ppb                   Default: 12*10.        !  BCKNH3 =
12*1.0 !

     Nighttime SO2 loss rate (RNITE1)
```

```
    in percent/hour                     Default: 0.2        ! RNITE1 = .2
!

    Nighttime NOx loss rate (RNITE2)
    in percent/hour                     Default: 2.0        ! RNITE2 =
2.0 !

    Nighttime HNO3 formation rate (RNITE3)
    in percent/hour                     Default: 2.0        ! RNITE3 =
2.0 !

    H2O2 data input option (MH2O2)      Default: 1          ! MH2O2 =  0
!
     (Used only if MAQCHEM = 1)
        0 = use a monthly background H2O2 value
        1 = read hourly H2O2 concentrations from
            the H2O2.DAT data file

    Monthly H2O2 concentrations
    (Used only if MQACHEM = 1 and
     MH2O2 = 0 or MH2O2 = 1 and all hourly H2O2 data missing)
    (BCKH2O2) in ppb                     Default: 12*1.       !  BCKH2O2 =
12*1.0 !


 --- Data for SECONDARY ORGANIC AEROSOL (SOA) Option
     (used only if MCHEM = 4)

     The SOA module uses monthly values of:
          Fine particulate concentration in ug/m^3 (BCKPMF)
          Organic fraction of fine particulate     (OFRAC)
          VOC / NOX ratio (after reaction)         (VCNX)
     to characterize the air mass when computing
     the formation of SOA from VOC emissions.
     Typical values for several distinct air mass types are:

        Month    1    2    3    4    5    6    7    8    9   10   11   12
                Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec

     Clean Continental
        BCKPMF   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.   1.
        OFRAC  .15  .15  .20  .20  .20  .20  .20  .20  .20  .20  .20  .15
        VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.

     Clean Marine (surface)
        BCKPMF  .5   .5   .5   .5   .5   .5   .5   .5   .5   .5   .5   .5
        OFRAC  .25  .25  .30  .30  .30  .30  .30  .30  .30  .30  .30  .25
        VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.  50.

     Urban - low biogenic (controls present)
        BCKPMF  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.  30.
        OFRAC  .20  .20  .25  .25  .25  .25  .25  .25  .20  .20  .20  .20
        VCNX     4.   4.   4.   4.   4.   4.   4.   4.   4.   4.   4.   4.
```

```
Urban - high biogenic (controls present)
   BCKPMF  60.   60.   60.   60.   60.   60.   60.   60.   60.   60.   60.   60.
   OFRAC  .25   .25   .30   .30   .30   .55   .55   .55   .35   .35   .35   .25
   VCNX    15.   15.   15.   15.   15.   15.   15.   15.   15.   15.   15.   15.

Regional Plume
   BCKPMF  20.   20.   20.   20.   20.   20.   20.   20.   20.   20.   20.   20.
   OFRAC  .20   .20   .25   .35   .25   .40   .40   .40   .30   .30   .30   .20
   VCNX    15.   15.   15.   15.   15.   15.   15.   15.   15.   15.   15.   15.

Urban - no controls present
   BCKPMF 100.  100.  100.  100.  100.  100.  100.  100.  100.  100.  100.  100.
   OFRAC  .30   .30   .35   .35   .35   .55   .55   .55   .35   .35   .35   .30
   VCNX     2.    2.    2.    2.    2.    2.    2.    2.    2.    2.    2.    2.

Default: Clean Continental
   !  BCKPMF = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00,
1.00, 1.00, 1.00 !
   !  OFRAC  = 0.15, 0.15, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20,
0.20, 0.20, 0.15 !
   !  VCNX   = 50.0, 50.0, 50.0, 50.0, 50.0, 50.0, 50.0, 50.0, 50.0,
50.0, 50.0, 50.0 !


!END!


--------------------------------------------------------------------------------
-----


INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters
---------------

    Horizontal size of puff (m) beyond which
    time-dependent dispersion equations (Heffter)
    are used to determine sigma-y and
    sigma-z (SYTDEP)                              Default: 550.    ! SYTDEP =
550.0 !

    Switch for using Heffter equation for sigma z
    as above (0 = Not use Heffter; 1 = use Heffter
    (MHFTSZ)                                      Default: 0       ! MHFTSZ =
0 !

    Stability class used to determine plume
    growth rates for puffs above the boundary
    layer (JSUP)                                  Default: 5       ! JSUP =
5   !

    Vertical dispersion constant for stable
    conditions (k1 in Eqn. 2.7-3)  (CONK1)        Default: 0.01    ! CONK1 =
.01 !
```

```
     Vertical dispersion constant for neutral/
     unstable conditions (k2 in Eqn. 2.7-4)
     (CONK2)                                     Default: 0.1     ! CONK2 =
.1 !

     Factor for determining Transition-point from
     Schulman-Scire to Huber-Snyder Building Downwash
     scheme (SS used for Hs < Hb + TBD * HL)
     (TBD)                                       Default: 0.5     ! TBD = .5
!
        TBD < 0    ==> always use Huber-Snyder
        TBD = 1.5 ==> always use Schulman-Scire
        TBD = 0.5 ==> ISC Transition-point

     Range of land use categories for which
     urban dispersion is assumed
     (IURB1, IURB2)                              Default: 10      ! IURB1 =
1  !  **wrf urban**
                                                          19      ! IURB2 =
1  !

     Site characterization parameters for single-point Met data files ----
-----
     (needed for METFM = 2,3,4,5)

        Land use category for modeling domain
        (ILANDUIN)                               Default: 20      ! ILANDUIN
=  20 !

        Roughness length (m) for modeling domain
        (Z0IN)                                   Default: 0.25    ! Z0IN =
.25 !

        Leaf area index for modeling domain
        (XLAIIN)                                 Default: 3.0     ! XLAIIN =
3.0 !

        Elevation above sea level (m)
        (ELEVIN)                                 Default: 0.0     ! ELEVIN =
.0 !

        Latitude (degrees) for met location
        (XLATIN)                                 Default: -999.   ! XLATIN =
-999.0 !

        Longitude (degrees) for met location
        (XLONIN)                                 Default: -999.   ! XLONIN =
-999.0 !

     Specialized information for interpreting single-point Met data files
-----

        Anemometer height (m) (Used only if METFM = 2,3)
```

```
        (ANEMHT)                                 Default: 10.     ! ANEMHT =
10.0 !

        Form of lateral turbulance data in PROFILE.DAT file
        (Used only if METFM = 4,5 or MTURBVW = 1 or 3)
        (ISIGMAV)                                Default: 1       ! ISIGMAV
= 1  !
            0 = read sigma-theta
            1 = read sigma-v

        Choice of mixing heights (Used only if METFM = 4)
        (IMIXCTDM)                               Default: 0       ! IMIXCTDM
= 0  !
            0 = read PREDICTED mixing heights
            1 = read OBSERVED mixing heights

     Maximum length of a slug (met. grid units)
     (XMXLEN)                                    Default: 1.0     ! XMXLEN =
1.0 !

     Maximum travel distance of a puff/slug (in
     grid units) during one sampling step
     (XSAMLEN)                                   Default: 1.0     ! XSAMLEN
= 1.0 !

     Maximum Number of slugs/puffs release from
     one source during one time step
     (MXNEW)                                     Default: 99      ! MXNEW =
99   !

     Maximum Number of sampling steps for
     one puff/slug during one time step
     (MXSAM)                                     Default: 99      ! MXSAM =
99  !

     Number of iterations used when computing
     the transport wind for a sampling step
     that includes gradual rise (for CALMET
     and PROFILE winds)
     (NCOUNT)                                    Default: 2       ! NCOUNT =
2   !

     Minimum sigma y for a new puff/slug (m)
     (SYMIN)                                     Default: 1.0     ! SYMIN =
1.0  !

     Minimum sigma z for a new puff/slug (m)
     (SZMIN)                                     Default: 1.0     ! SZMIN =
1.0  !

     Default minimum turbulence velocities sigma-v and sigma-w
     for each stability class over land and over water (m/s)
     (SVMIN(12) and SWMIN(12))
```

```
              ----------  LAND  ----------        ---------  WATER
----------
       Stab Class :  A    B    C    D    E    F       A    B    C    D
E   F
                    ---  ---  ---  ---  ---  ---      ---  ---  ---  ---
---  ---
    Default SVMIN : .50, .50, .50, .50, .50, .50,     .37, .37, .37,
.37, .37, .37
    Default SWMIN : .20, .12, .08, .06, .03, .016,    .20, .12, .08,
.06, .03, .016

         * SVMIN = 0.500, 0.500, 0.500, 0.500, 0.500, 0.500,  0.370,
0.370, 0.370, 0.370, 0.370, 0.370 *
         ! SVMIN = 12* 0.5 ! MREG = 1 requirement

         ! SWMIN = 0.200, 0.120, 0.080, 0.060, 0.030, 0.016,  0.200,
0.120, 0.080, 0.060, 0.030, 0.016!

    Divergence criterion for dw/dz across puff
    used to initiate adjustment for horizontal
    convergence (1/s)
    Partial adjustment starts at CDIV(1), and
    full adjustment is reached at CDIV(2)
    (CDIV(2))                               Default: 0.0,0.0  ! CDIV =
0.0, 0.0 !

    Minimum wind speed (m/s) allowed for
    non-calm conditions. Also used as minimum
    speed returned when using power-law
    extrapolation toward surface
    (WSCALM)                                Default: 0.5     ! WSCALM =
.5 !

    Maximum mixing height (m)
    (XMAXZI)                                Default: 3000.   ! XMAXZI =
3000.0 !

    Minimum mixing height (m)
    (XMINZI)                                Default: 50.     ! XMINZI =
50.0 !

    Default wind speed classes --
    5 upper bounds (m/s) are entered;
    the 6th class has no upper limit
    (WSCAT(5))                  Default      :
                                ISC RURAL : 1.54, 3.09, 5.14, 8.23,
10.8 (10.8+)

                          Wind Speed Class :  1     2     3     4
5
                                             ---   ---   ---   ---   -
--
                               ! WSCAT = 1.54, 3.09, 5.14, 8.23,
10.80 !
```

```
     Default wind speed profile power-law
     exponents for stabilities 1-6
     (PLX0(6))                              Default    : ISC RURAL values
                                            ISC RURAL : .07, .07, .10, .15, .35,
.55
                                            ISC URBAN : .15, .15, .20, .25, .30,
.30
                                  Stability Class :  A     B     C     D
E     F
                                                    ---   ---   ---   ---   -
--    ---
                                         ! PLX0 = 0.07, 0.07, 0.10, 0.15,
0.35, 0.55 !

     Default potential temperature gradient
     for stable classes E, F (degK/m)
     (PTG0(2))                              Default: 0.020, 0.035
                                         ! PTG0 = 0.020,    0.035 !


     Default plume path coefficients for
     each stability class (used when option
     for partial plume height terrain adjustment
     is selected -- MCTADJ=3)
     (PPC(6))                      Stability Class :  A     B     C     D
E     F
                                      Default  PPC : .50,  .50,  .50,  .50,
.35,  .35
                                                    ---   ---   ---   ---   -
--    ---
                                         !  PPC = 0.50, 0.50, 0.50, 0.50,
0.35, 0.35 !

     Slug-to-puff transition criterion factor
     equal to sigma-y/length of slug
     (SL2PF)                                   Default: 10.        ! SL2PF =
10.0!

     Puff-splitting control variables ------------------------

       VERTICAL SPLIT
       --------------

       Number of puffs that result every time a puff
       is split - nsplit=2 means that 1 puff splits
       into 2
       (NSPLIT)                                Default:   3        ! NSPLIT =
3  !

       Time(s) of a day when split puffs are eligible to
       be split once again; this is typically set once
       per day, around sunset before nocturnal shear develops.
       24 values: 0 is midnight (00:00) and 23 is 11 PM (23:00)
```

```
      0=do not re-split    1=eligible for re-split
      (IRESPLIT(24))                    Default:  Hour 17 = 1
      !  IRESPLIT = 0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0 !

      Split is allowed only if last hour's mixing
      height (m) exceeds a minimum value
      (ZISPLIT)                         Default: 100.       ! ZISPLIT =
100.0 !

      Split is allowed only if ratio of last hour's
      mixing ht to the maximum mixing ht experienced
      by the puff is less than a maximum value (this
      postpones a split until a nocturnal layer develops)
      (ROLDMAX)                         Default: 0.25       ! ROLDMAX =
0.25 !


      HORIZONTAL SPLIT
      ----------------

      Number of puffs that result every time a puff
      is split - nsplith=5 means that 1 puff splits
      into 5
      (NSPLITH)                         Default:   5        ! NSPLITH =
5  !

      Minimum sigma-y (Grid Cells Units) of puff
      before it may be split
      (SYSPLITH)                        Default:  1.0       ! SYSPLITH
= 1.0 !

      Minimum puff elongation rate (SYSPLITH/hr) due to
      wind shear, before it may be split
      (SHSPLITH)                        Default:  2.        ! SHSPLITH
= 2.0 !

      Minimum concentration (g/m^3) of each
      species in puff before it may be split
      Enter array of NSPEC values; if a single value is
      entered, it will be used for ALL species
      (CNSPLITH)                        Default:  1.0E-07   ! CNSPLITH
= 1.0E-07 !

     Integration control variables -----------------------

      Fractional convergence criterion for numerical SLUG
      sampling integration
      (EPSSLUG)                         Default:   1.0e-04  ! EPSSLUG =
1.0E-04 !

      Fractional convergence criterion for numerical AREA
      source integration
      (EPSAREA)                         Default:   1.0e-06  ! EPSAREA =
1.0E-06 !
```

```
     Trajectory step-length (m) used for numerical rise
     integration
     (DSRISE)                             Default:   1.0       ! DSRISE =
1.0 !

   Boundary Condition (BC) Puff control variables ----------------------
--

     Minimum height (m) to which BC puffs are mixed as they are emitted
     (MBCON=2 ONLY).  Actual height is reset to the current mixing
height
     at the release point if greater than this minimum.
     (HTMINBC)                            Default:   500.      ! HTMINBC =
500. !

     Search radius (km) about a receptor for sampling nearest BC puff.
     BC puffs are typically emitted with a spacing of one grid cell
     length, so the search radius should be greater than DGRIDKM.
     (RSAMPBC)                            Default:   10.       ! RSAMPBC =
10 !

     Near-Surface depletion adjustment to concentration profile used
when
     sampling BC puffs?
     (MDEPBC)                             Default:   1         ! MDEPBC =
1  !
        0 = Concentration is NOT adjusted for depletion
        1 = Adjust Concentration for depletion

!END!

-------------------------------------------------------------------------
-----

INPUT GROUPS: 13a, 13b, 13c, 13d -- Point source parameters
---------------------------------

---------------
Subgroup (13a)
---------------

    Number of point sources with
    parameters provided below         (NPT1)  No default  !  NPT1 = 17 !

    Units used for point source
    emissions below                   (IPTU)  Default: 1  !  IPTU =   1 !
          1 =       g/s
          2 =      kg/hr
          3 =      lb/hr
          4 =    tons/yr
          5 =    Odour Unit * m**3/s  (vol. flux of odour compound)
```

```
            6 =      Odour Unit * m**3/min
            7 =      metric tons/yr

        Number of source-species
        combinations with variable
        emissions scaling factors
        provided below in (13d)          (NSPT1) Default: 0  !  NSPT1 =  0  !

        Number of point sources with
        variable emission parameters
        provided in external file        (NPT2)  No default  !  NPT2 =  0  !

        (If NPT2 > 0, these point
        source emissions are read from
        the file: PTEMARB.DAT)

!END!

---------------
Subgroup (13b)
---------------
                                                   a
          POINT SOURCE: CONSTANT DATA
          -----------------------------

b         c
  Source       X UTM      Y UTM      Stack    Base      Stack     Exit  Exit
Bldg.  Emission
   No.     Coordinate Coordinate Height Elevation Diameter  Vel.  Temp.
Dwash   Rates
                (km)       (km)       (m)       (m)         (m)  (m/s) (deg. K)
  ------   ----------  ----------  ------  ------  --------  -----  --------
----- --------
*** Max short-term  emission rates ***
*** The species starting with "n" (the last four) are non-reactive
versions ***
     X         Y          Ht Elev Diam Vel    Temp  DW SO2      SO4       NOX
HNO3 NO3      EC       SOA     PMC PMF nSO2 nNOx nPM10 nPM25
! SRCNAM = GMT2HT !
! X = 125.12678, 22.83898, 12.2, 33.259, 0.94, 5.7, 529, 0, 2.49E-
04,9.96E-05,2.33E-02,0,3.16E-06,1.10E-04,3.05E-04,2.92E-04,1.93E-03,2.49E-
04,2.33E-02,2.78E-03,0.00E+00 !
! END !
! SRCNAM = CAMPGEN !
! X = 125.11929, 22.93334, 6.5, 33.259, 0.2, 47, 761, 0, 4.62E-04,8.98E-
06,4.94E-01,0,1.34E-05,3.01E-03,1.47E-02,0.00E+00,6.99E-03,4.62E-04,4.94E-
01,2.47E-02,2.47E-02 !
! END !
! SRCNAM = DRILLPE !
! X = 125.0211, 22.86409, 13.3, 33.210, 0.4, 10.5, 614, 0, 5.64E-04,2.58E-
03,3.65E-01,0,3.22E-05,0.00E+00,7.41E-04,0.00E+00,1.08E-02,5.64E-04,3.65E-
01,1.51E-02,0.00E+00 !
! END !
! SRCNAM = DRILLCP1 !
```

```
! X = 125.01318, 22.8738, 10.4, 33.206, 0.13, 43.5, 750, 0, 1.07E-
05,9.76E-05,1.88E-02,0,1.22E-06,0.00E+00,2.80E-05,0.00E+00,4.07E-04,1.07E-
05,1.88E-02,5.71E-04,0.00E+00 !
! END !
! SRCNAM = DRILLCP2 !
! X = 125.01679, 22.86911, 10.4, 33.208, 0.13, 43.5, 750, 0, 1.07E-
05,9.76E-05,1.88E-02,0,1.22E-06,0.00E+00,2.80E-05,0.00E+00,4.07E-04,1.07E-
05,1.88E-02,5.71E-04,0.00E+00 !
! END !
! SRCNAM = DRILLB1 !
! X = 125.02335, 22.8783, 11.9, 33.211, 0.279, 11.7, 450, 0, 6.49E-
04,4.06E-04,6.10E-02,0,1.06E-04,2.49E-03,2.24E-03,7.62E-04,1.06E-03,6.49E-
04,6.10E-02,7.25E-03,0.00E+00 !
! END !
! SRCNAM = DRILLB2 !
! X = 125.02627, 22.87358, 11.9, 33.213, 0.279, 11.7, 450, 0, 6.49E-
04,4.06E-04,6.10E-02,0,1.06E-04,2.49E-03,2.24E-03,7.62E-04,1.06E-03,6.49E-
04,6.10E-02,7.25E-03,0.00E+00 !
! END !
! SRCNAM = DRILLAH1 !
! X = 125.03029, 22.88165, 10.5, 33.215, 0.3, 3.2, 533, 0, 7.75E-04,3.11E-
04,7.28E-02,0,9.85E-06,3.42E-04,9.52E-04,9.10E-04,6.02E-03,7.75E-04,7.28E-
02,8.66E-03,0.00E+00 !
! END !
! SRCNAM = DRILLAH2 !
! X = 125.03231, 22.88311, 10.5, 33.216, 0.3, 3.2, 533, 0, 3.88E-04,1.55E-
04,3.64E-02,0,4.93E-06,1.71E-04,4.76E-04,4.55E-04,3.01E-03,3.88E-04,3.64E-
02,4.33E-03,0.00E+00 !
! END !
! SRCNAM = DRILLMP !
! X = 125.03045, 22.87736, 7.2, 33.215, 0.3, 10.8, 533, 0, 5.81E-04,2.33E-
04,5.46E-02,0,7.39E-06,2.56E-04,7.14E-04,6.82E-04,4.51E-03,5.81E-04,5.46E-
02,6.50E-03,0.00E+00 !
! END !
! SRCNAM = DRILLFLARE !
! X = 125.14489, 22.84136, 10.1429569, 33.267, 0.3, 6.096, 1033.15, 0,
3.88E-03,8.18E-06,6.77E-02,0,1.02E-07,0.00E+00,2.35E-06,0.00E+00,3.41E-
05,3.88E-03,6.77E-02,4.79E-05,0.00E+00 !
! END !
! SRCNAM = DRILLEG !
! X = 125.25235, 23.00777, 6.1, 33.323, 0.46, 15.1, 795, 0, 6.03E-
05,2.35E-06,7.58E-02,0,3.50E-06,7.86E-04,3.83E-03,0.00E+00,1.83E-03,6.03E-
05,7.58E-02,6.45E-03,0.00E+00 !
! END !
! SRCNAM = FRACENG1 !
! X = 125.04908, 22.89436, 3.7, 33.224, 0.356, 41.6, 644, 0, 5.69E-
05,1.50E-04,2.18E-02,0,1.88E-06,0.00E+00,4.31E-05,1.30E-04,6.28E-04,5.69E-
05,2.18E-02,1.01E-03,0.00E+00 !
! END !
! SRCNAM = FRACENG2 !
! X = 125.05935, 22.88207, 3.7, 33.229, 0.356, 41.6, 644, 0, 5.69E-
05,1.50E-04,2.18E-02,0,1.88E-06,0.00E+00,4.31E-05,1.30E-04,6.28E-04,5.69E-
05,2.18E-02,1.01E-03,0.00E+00 !
! END !
```

```
! SRCNAM = OPSLH !
! X = 125.1883, 22.9999, 12.2, 33.293, 0.94, 5.7, 529, 0, 5.53E-03,1.96E-
03,1.51E-01,0,2.44E-05,0.00E+00,5.62E-04,0.00E+00,8.18E-03,5.53E-03,1.51E-
01,1.15E-02,0.00E+00 !
! END !
! SRCNAM = OPSEMGEN !
! X = 125.11929, 22.93334, 6.1, 33.259, 0.46, 15.1, 795, 0, 2.39E-
04,1.18E-06,1.04E-01,0,1.76E-06,3.95E-04,1.92E-03,0.00E+00,9.17E-04,2.39E-
04,1.04E-01,3.24E-03,0.00E+00 !
! END !
! SRCNAM = GRVLHT !
! X = 125.0553, 22.88217, 12.2, 33.227, 0.94, 5.7, 529, 0,
0,0,0,0,0,0,0,0,0,0,0,0,0.003646717 !
! END !
--------
```

a
Data for each source are treated as a separate input subgroup and therefore must end with an input group terminator.

SRCNAM is a 12-character name for a source
(No default)

X is an array holding the source data listed by the column headings
(No default)

SIGYZI is an array holding the initial sigma-y and sigma-z (m)
(Default: 0.,0.)

FMFAC is a vertical momentum flux factor (0. or 1.0) used to represent the effect of rain-caps or other physical configurations that reduce momentum rise associated with the actual exit velocity.
(Default: 1.0 -- full momentum used)

ZPLTFM is the platform height (m) for sources influenced by an isolated structure that has a significant open area between the surface and the bulk of the structure, such as an offshore oil platform.
The Base Elevation is that of the surface (ground or ocean), and the Stack Height is the release height above the Base (not above the platform). Building heights entered in Subgroup 13c must be those of the buildings on the platform, measured from the platform deck. ZPLTFM is used only with MBDW=1 (ISC downwash method) for sources with building downwash.
(Default: 0.0)

b
0. = No building downwash modeled
1. = Downwash modeled for buildings resting on the surface
2. = Downwash modeled for buildings raised above the surface (ZPLTFM > 0.)

```
     NOTE: must be entered as a REAL number (i.e., with decimal point)

    c
     An emission rate must be entered for every pollutant modeled.
     Enter emission rate of zero for secondary pollutants that are
     modeled, but not emitted.  Units are specified by IPTU
     (e.g. 1 for g/s).

---------------
Subgroup (13c)
---------------

          BUILDING DIMENSION DATA FOR SOURCES SUBJECT TO DOWNWASH
          -------------------------------------------------------
Source
a
 No.      Effective building height, width, length and X/Y offset (in
meters)
          every 10 degrees.  LENGTH, XBADJ, and YBADJ are only needed for
          MBDW=2 (PRIME downwash option)
------    ---------------------------------------------------------------
----


--------


    a
     Building height, width, length, and X/Y offset from the source are
treated
     as a separate input subgroup for each source and therefore must end
with
     an input group terminator.

---------------
Subgroup (13d)
---------------
                                                    a
         POINT SOURCE: VARIABLE EMISSIONS DATA
         ---------------------------------------

     Use this subgroup to describe temporal variations in the emission
     rates given in 13b.  Factors entered multiply the rates in 13b.
     Skip sources here that have constant emissions.  For more elaborate
     variation in source parameters, use PTEMARB.DAT and NPT2 > 0.

     IVARY determines the type of variation, and is source-specific:
     (IVARY)                                Default: 0
           0 =        Constant
           1 =        Diurnal cycle (24 scaling factors: hours 1-24)
           2 =        Monthly cycle (12 scaling factors: months 1-12)
           3 =        Hour & Season (4 groups of 24 hourly scaling factors,
                                     where first group is DEC-JAN-FEB)
           4 =        Speed & Stab. (6 groups of 6 scaling factors, where
                                     first group is Stability Class A,
```

```
                                     and the speed classes have upper
                                     bounds (m/s) defined in Group 12
         5 =        Temperature     (12 scaling factors, where temperature
                                     classes have upper bounds (C) of:
                                     0, 5, 10, 15, 20, 25, 30, 35, 40,
                                     45, 50, 50+)


--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.

------------------------------------------------------------------------------
-----

INPUT GROUPS: 14a, 14b, 14c, 14d -- Area source parameters
--------------------------------

---------------
Subgroup (14a)
---------------

     Number of polygon area sources with
     parameters specified below (NAR1)       No default  !  NAR1 =  0   !

     Units used for area source
     emissions below                (IARU)   Default: 1  !  IARU =   1  !
          1 =          g/m**2/s
          2 =         kg/m**2/hr
          3 =         lb/m**2/hr
          4 =       tons/m**2/yr
          5 =       Odour Unit * m/s  (vol. flux/m**2 of odour compound)
          6 =       Odour Unit * m/min
          7 =       metric tons/m**2/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (14d)       (NSAR1) Default: 0  !  NSAR1 =  0   !

     Number of buoyant polygon area sources
     with variable location and emission
     parameters (NAR2)                      No default  !  NAR2 =  0    !
     (If NAR2 > 0, ALL parameter data for
     these sources are read from the file: BAEMARB.DAT)

!END!

---------------
Subgroup (14b)
```

AREA SOURCE: CONSTANT DATA[a]

Source No.	Effect. Height (m)	Base Elevation (m)	Initial Sigma z (m)	Emission Rates[b]

----

[a] Data for each source are treated as a separate input subgroup and therefore must end with an input group terminator.

[b] An emission rate must be entered for every pollutant modeled. Enter emission rate of zero for secondary pollutants that are modeled, but not emitted. Units are specified by IARU (e.g. 1 for g/m**2/s).

Subgroup (14c)

COORDINATES (UTM-km) FOR EACH VERTEX(4) OF EACH POLYGON

Source No.	Ordered list of X followed by list of Y, grouped by source[a]

----

[a] Data for each source are treated as a separate input subgroup and therefore must end with an input group terminator.

Subgroup (14d)

AREA SOURCE: VARIABLE EMISSIONS DATA[a]

Use this subgroup to describe temporal variations in the emission rates given in 14b. Factors entered multiply the rates in 14b. Skip sources here that have constant emissions. For more elaborate variation in source parameters, use BAEMARB.DAT and NAR2 > 0.

IVARY determines the type of variation, and is source-specific:
(IVARY) Default: 0

0 = Constant
1 = Diurnal cycle (24 scaling factors: hours 1-24)

```
        2 =      Monthly cycle (12 scaling factors: months 1-12)
        3 =      Hour & Season (4 groups of 24 hourly scaling factors,
                               where first group is DEC-JAN-FEB)
        4 =      Speed & Stab. (6 groups of 6 scaling factors, where
                               first group is Stability Class A,
                               and the speed classes have upper
                               bounds (m/s) defined in Group 12
        5 =      Temperature   (12 scaling factors, where temperature
                               classes have upper bounds (C) of:
                               0, 5, 10, 15, 20, 25, 30, 35, 40,
                               45, 50, 50+)
```

----
[a]
Data for each species are treated as a separate input subgroup and therefore must end with an input group terminator.

```
--------------------------------------------------------------------------------
-----

INPUT GROUPS: 15a, 15b, 15c -- Line source parameters
---------------------------

---------------
Subgroup (15a)
---------------

     Number of buoyant line sources
     with variable location and emission
     parameters (NLN2)                             No default   !  NLN2 =
0   !

     (If NLN2 > 0, ALL parameter data for
      these sources are read from the file: LNEMARB.DAT)

     Number of buoyant line sources (NLINES)       No default   ! NLINES
=  0  !

     Units used for line source
     emissions below              (ILNU)           Default: 1   !  ILNU =
1  !
          1 =       g/s
          2 =      kg/hr
          3 =      lb/hr
          4 =    tons/yr
          5 =    Odour Unit * m**3/s  (vol. flux of odour compound)
          6 =    Odour Unit * m**3/min
          7 =    metric tons/yr

     Number of source-species
     combinations with variable
```

```
      emissions scaling factors
      provided below in (15c)          (NSLN1) Default: 0  !  NSLN1 =  0  !

      Maximum number of segments used to model
      each line (MXNSEG)                             Default: 7    ! MXNSEG
=  7  !

      The following variables are required only if NLINES > 0.  They are
      used in the buoyant line source plume rise calculations.

         Number of distances at which                Default: 6    ! NLRISE
=  6  !
         transitional rise is computed

         Average building length (XL)                No default    ! XL = .0
!
                                                     (in meters)

         Average building height (HBL)               No default    ! HBL =
.0 !
                                                     (in meters)

         Average building width (WBL)                No default    ! WBL =
.0 !
                                                     (in meters)

         Average line source width (WML)             No default    ! WML =
.0 !
                                                     (in meters)

         Average separation between buildings (DXL)  No default    ! DXL =
.0 !
                                                     (in meters)

         Average buoyancy parameter (FPRIMEL)        No default    ! FPRIMEL
= .0 !
                                                     (in m**4/s**3)

!END!

---------------
Subgroup (15b)
---------------

           BUOYANT LINE SOURCE: CONSTANT DATA
           ----------------------------------

a
Source      Beg. X      Beg. Y      End. X     End. Y      Release     Base
Emission
 No.    Coordinate  Coordinate  Coordinate Coordinate   Height
Elevation      Rates
            (km)        (km)        (km)        (km)        (m)         (m)
```

------ ---------- ---------- --------- ---------- ------- --------
- ---------

----

a
Data for each source are treated as a separate input subgroup and therefore must end with an input group terminator.

b
An emission rate must be entered for every pollutant modeled. Enter emission rate of zero for secondary pollutants that are modeled, but not emitted. Units are specified by ILNTU (e.g. 1 for g/s).

Subgroup (15c)

BUOYANT LINE SOURCE: VARIABLE EMISSIONS DATA[a]

Use this subgroup to describe temporal variations in the emission rates given in 15b. Factors entered multiply the rates in 15b. Skip sources here that have constant emissions.

IVARY determines the type of variation, and is source-specific:

(IVARY) Default: 0

0 =	Constant	
1 =	Diurnal cycle	(24 scaling factors: hours 1-24)
2 =	Monthly cycle	(12 scaling factors: months 1-12)
3 =	Hour & Season	(4 groups of 24 hourly scaling factors, where first group is DEC-JAN-FEB)
4 =	Speed & Stab.	(6 groups of 6 scaling factors, where first group is Stability Class A, and the speed classes have upper bounds (m/s) defined in Group 12
5 =	Temperature	(12 scaling factors, where temperature classes have upper bounds (C) of: 0, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 50+)

----

a
Data for each species are treated as a separate input subgroup and therefore must end with an input group terminator.


```
INPUT GROUPS: 16a, 16b, 16c -- Volume source parameters
---------------------------

---------------
Subgroup (16a)
---------------

     Number of volume sources with
     parameters provided in 16b,c (NVL1)     No default  !  NVL1 = 222   !

     Units used for volume source
     emissions below in 16b        (IVLU)     Default: 1  !  IVLU =   1  !
           1 =       g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
           5 =     Odour Unit * m**3/s  (vol. flux of odour compound)
           6 =     Odour Unit * m**3/min
           7 =     metric tons/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (16c)       (NSVL1)    Default: 0  !  NSVL1 =   0  !

     Number of volume sources with
     variable location and emission
     parameters                    (NVL2)     No default  !  NVL2 =   0   !

     (If NVL2 > 0, ALL parameter data for
      these sources are read from the VOLEMARB.DAT file(s) )

!END!

---------------
Subgroup (16b)
---------------
                                           a
           VOLUME SOURCE: CONSTANT DATA
           ------------------------------

b
        X UTM       Y UTM       Effect.     Base       Initial     Initial
Emission
     Coordinate  Coordinate    Height    Elevation   Sigma y     Sigma z
Rates
        (km)        (km)         (m)        (m)         (m)         (m)
     ----------  ----------    ------    ------      --------    --------    --
------
*** Max short-term  emission rates ***
       X       Y          Ht Elev sigma-y sigma-z  SO2       SO4       NOX
HNO3 NO3      EC       SOA     PMC PMF nSO2 nNOx nPM10 nPM25
! SRCNAM = GMT2NR !
```

```
! X = 124.60761, 22.82642, 3.66, 33.012, 62.46108995, 3.37627907, 1.54E-
04,1.48E-05,1.07E-01,0,6.09E-06,5.31E-03,1.51E-03,2.13E-04,3.59E-05,1.54E-
04,1.07E-01,7.10E-03,6.89E-03 !
! END !
! SRCNAM = CONFE !
! X = 124.60761, 22.82642, 3.66, 33.012, 62.46108995, 3.37627907,
0.00E+00,6.50E-04,0,0,2.41E-05,0,5.51E-03,6.39E-01,7.87E-
02,0.00E+00,0.00E+00,7.24E-01,8.52E-02 !
! END !
! SRCNAM = DRILLNR !
! X = 124.60761, 22.82642, 3.66, 33.012, 62.46108995, 3.37627907, 8.94E-
04,3.10E-05,1.41E-01,0,1.28E-05,1.11E-02,3.17E-03,1.00E-03,7.52E-05,8.94E-
04,1.41E-01,1.54E-02,1.44E-02 !
! END !
! SRCNAM = FRACNR !
! X = 124.60761, 22.82642, 3.66, 33.012, 62.46108995, 3.37627907, 3.41E-
05,1.18E-06,5.38E-03,0,4.87E-07,4.24E-04,1.21E-04,3.83E-05,2.87E-06,3.41E-
05,5.38E-03,5.88E-04,5.50E-04 !
! END !
! SRCNAM = PADNR !
! X = 124.60761, 22.82642, 3.66, 33.012, 62.46108995, 3.37627907,
0.00E+00,0.00E+00,0.00E+00,0,0.00E+00,0.00E+00,0.00E+00,0.00E+00,0.00E+00,
0.00E+00,0.00E+00,0.00E+00,6.24E-03 !
! END !
! SRCNAM = PADFE !
! X = 124.60761, 22.82642, 3.66, 33.012, 62.46108995, 0.851,
0.00E+00,0.00E+00,0.00E+00,0,0.00E+00,0.00E+00,0.00E+00,0.00E+00,0.00E+00,
0.00E+00,0.00E+00,0.00E+00,8.51E-03 !
! END !
! SRCNAM = S2CONTAIL1 !
! X = 125.17384, 23.17569, 3.66, 33.292, 7.302325581, 3.37627907, 2.19E-
05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-
05,7.80E-03,9.37E-04,4.48E-04 !
! END !
! SRCNAM = S2CONTAIL2 !
! X = 125.60973, 23.39549, 3.66, 33.494, 7.302325581, 3.37627907, 2.19E-
05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-
05,7.80E-03,9.37E-04,4.48E-04 !
! END !
! SRCNAM = S2CONTAIL3 !
! X = 126.08181, 23.55943, 3.66, 33.704, 7.302325581, 3.37627907, 2.19E-
05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-
05,7.80E-03,9.37E-04,4.48E-04 !
! END !
! SRCNAM = S2CONTAIL4 !
! X = 126.55388, 23.72337, 3.66, 33.905, 7.302325581, 3.37627907, 2.19E-
05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-
05,7.80E-03,9.37E-04,4.48E-04 !
! END !
! SRCNAM = S2CONTAIL5 !
! X = 127.02594, 23.88732, 3.66, 34.100, 7.302325581, 3.37627907, 2.19E-
05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-
05,7.80E-03,9.37E-04,4.48E-04 !
! END !
```

```
! SRCNAM = S2CONTAIL6 !
! X = 127.498, 24.05127, 3.66, 34.289, 7.302325581, 3.37627907, 2.19E-
05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-
05,7.80E-03,9.37E-04,4.48E-04 !
! END !
! SRCNAM = S2CONTAIL7 !
! X = 127.92559, 24.29415, 3.66, 34.474, 7.302325581, 3.37627907, 2.19E-
05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-
05,7.80E-03,9.37E-04,4.48E-04 !
! END !
! SRCNAM = S2CONTAIL8 !
! X = 128.27261, 24.65372, 3.66, 34.453, 7.302325581, 3.37627907, 2.19E-
05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-
05,7.80E-03,9.37E-04,4.48E-04 !
! END !
! SRCNAM = S2CONTAIL9 !
! X = 128.53706, 25.0671, 3.66, 34.399, 7.302325581, 3.37627907, 2.19E-
05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-
05,7.80E-03,9.37E-04,4.48E-04 !
! END !
! SRCNAM = S2CONTAIL10 !
! X = 128.63575, 25.55697, 3.66, 34.384, 7.302325581, 3.37627907, 2.19E-
05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-
05,7.80E-03,9.37E-04,4.48E-04 !
! END !
! SRCNAM = S2CONTAIL11 !
! X = 128.73444, 26.04682, 3.66, 34.369, 7.302325581, 3.37627907, 2.19E-
05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-
05,7.80E-03,9.37E-04,4.48E-04 !
! END !
! SRCNAM = S2CONTAIL12 !
! X = 128.83312, 26.53667, 3.66, 34.353, 7.302325581, 3.37627907, 2.19E-
05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-
05,7.80E-03,9.37E-04,4.48E-04 !
! END !
! SRCNAM = S2CONTAIL13 !
! X = 128.93181, 27.02652, 3.66, 34.335, 7.302325581, 3.37627907, 2.19E-
05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-
05,7.80E-03,9.37E-04,4.48E-04 !
! END !
! SRCNAM = S2CONTAIL14 !
! X = 129.07723, 27.50284, 3.66, 34.303, 7.302325581, 3.37627907, 2.19E-
05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-
05,7.80E-03,9.37E-04,4.48E-04 !
! END !
! SRCNAM = S2CONTAIL15 !
! X = 129.25515, 27.96976, 3.66, 34.260, 7.302325581, 3.37627907, 2.19E-
05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-
05,7.80E-03,9.37E-04,4.48E-04 !
! END !
! SRCNAM = S2CONTAIL16 !
! X = 129.43307, 28.43668, 3.66, 33.208, 7.302325581, 3.37627907, 2.19E-
05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-
05,7.80E-03,9.37E-04,4.48E-04 !
```

```
! END !
! SRCNAM = S2CONTAIL17 !
! X = 129.61098, 28.9036, 3.66, 32.115, 7.302325581, 3.37627907, 2.19E-05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-05,7.80E-03,9.37E-04,4.48E-04 !
! END !
! SRCNAM = S2CONTAIL18 !
! X = 129.78888, 29.3705, 3.66, 31.054, 7.302325581, 3.37627907, 2.19E-05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-05,7.80E-03,9.37E-04,4.48E-04 !
! END !
! SRCNAM = S2CONTAIL19 !
! X = 129.96679, 29.83741, 3.66, 30.022, 7.302325581, 3.37627907, 2.19E-05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-05,7.80E-03,9.37E-04,4.48E-04 !
! END !
! SRCNAM = S2CONTAIL20 !
! X = 130.14468, 30.30431, 3.66, 29.022, 7.302325581, 3.37627907, 2.19E-05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-05,7.80E-03,9.37E-04,4.48E-04 !
! END !
! SRCNAM = S2CONTAIL21 !
! X = 130.45329, 30.68139, 3.66, 28.271, 7.302325581, 3.37627907, 2.19E-05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-05,7.80E-03,9.37E-04,4.48E-04 !
! END !
! SRCNAM = S2CONTAIL22 !
! X = 130.82869, 31.00528, 3.66, 27.690, 7.302325581, 3.37627907, 2.19E-05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-05,7.80E-03,9.37E-04,4.48E-04 !
! END !
! SRCNAM = S2CONTAIL23 !
! X = 131.11633, 31.4138, 3.66, 26.956, 7.302325581, 3.37627907, 2.19E-05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-05,7.80E-03,9.37E-04,4.48E-04 !
! END !
! SRCNAM = S2CONTAIL24 !
! X = 131.40396, 31.82232, 3.66, 26.266, 7.302325581, 3.37627907, 2.19E-05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-05,7.80E-03,9.37E-04,4.48E-04 !
! END !
! SRCNAM = S2CONTAIL25 !
! X = 131.72987, 32.19849, 3.66, 25.308, 7.302325581, 3.37627907, 2.19E-05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-05,7.80E-03,9.37E-04,4.48E-04 !
! END !
! SRCNAM = S2CONTAIL26 !
! X = 132.08466, 32.55025, 3.66, 24.036, 7.302325581, 3.37627907, 2.19E-05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-05,7.80E-03,9.37E-04,4.48E-04 !
! END !
! SRCNAM = S2CONTAIL27 !
```

```
! X = 132.4931, 32.83098, 3.66, 22.759, 7.302325581, 3.37627907, 2.19E-
05,9.62E-07,7.80E-03,0,3.96E-07,3.46E-04,9.84E-05,4.89E-04,2.34E-06,2.19E-
05,7.80E-03,9.37E-04,4.48E-04 !
! END !
! SRCNAM = DRILLM1 !
! X = 125.17384, 23.17569, 3.66, 33.292, 7.302325581, 3.37627907, 1.81E-
06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-
06,4.06E-04,7.64E-05,3.48E-05 !
! END !
! SRCNAM = DRILLM2 !
! X = 125.60973, 23.39549, 3.66, 33.494, 7.302325581, 3.37627907, 1.81E-
06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-
06,4.06E-04,7.64E-05,3.48E-05 !
! END !
! SRCNAM = DRILLM3 !
! X = 126.08181, 23.55943, 3.66, 33.704, 7.302325581, 3.37627907, 1.81E-
06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-
06,4.06E-04,7.64E-05,3.48E-05 !
! END !
! SRCNAM = DRILLM4 !
! X = 126.55388, 23.72337, 3.66, 33.905, 7.302325581, 3.37627907, 1.81E-
06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-
06,4.06E-04,7.64E-05,3.48E-05 !
! END !
! SRCNAM = DRILLM5 !
! X = 127.02594, 23.88732, 3.66, 34.100, 7.302325581, 3.37627907, 1.81E-
06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-
06,4.06E-04,7.64E-05,3.48E-05 !
! END !
! SRCNAM = DRILLM6 !
! X = 127.498, 24.05127, 3.66, 34.289, 7.302325581, 3.37627907, 1.81E-
06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-
06,4.06E-04,7.64E-05,3.48E-05 !
! END !
! SRCNAM = DRILLM7 !
! X = 127.92559, 24.29415, 3.66, 34.474, 7.302325581, 3.37627907, 1.81E-
06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-
06,4.06E-04,7.64E-05,3.48E-05 !
! END !
! SRCNAM = DRILLM8 !
! X = 128.27261, 24.65372, 3.66, 34.453, 7.302325581, 3.37627907, 1.81E-
06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-
06,4.06E-04,7.64E-05,3.48E-05 !
! END !
! SRCNAM = DRILLM9 !
! X = 128.53706, 25.0671, 3.66, 34.399, 7.302325581, 3.37627907, 1.81E-
06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-
06,4.06E-04,7.64E-05,3.48E-05 !
! END !
! SRCNAM = DRILLM10 !
! X = 128.63575, 25.55697, 3.66, 34.384, 7.302325581, 3.37627907, 1.81E-
06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-
06,4.06E-04,7.64E-05,3.48E-05 !
! END !
```

```
! SRCNAM = DRILLM11 !
! X = 128.73444, 26.04682, 3.66, 34.369, 7.302325581, 3.37627907, 1.81E-06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-06,4.06E-04,7.64E-05,3.48E-05 !
! END !
! SRCNAM = DRILLM12 !
! X = 128.83312, 26.53667, 3.66, 34.353, 7.302325581, 3.37627907, 1.81E-06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-06,4.06E-04,7.64E-05,3.48E-05 !
! END !
! SRCNAM = DRILLM13 !
! X = 128.93181, 27.02652, 3.66, 34.335, 7.302325581, 3.37627907, 1.81E-06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-06,4.06E-04,7.64E-05,3.48E-05 !
! END !
! SRCNAM = DRILLM14 !
! X = 129.07723, 27.50284, 3.66, 34.303, 7.302325581, 3.37627907, 1.81E-06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-06,4.06E-04,7.64E-05,3.48E-05 !
! END !
! SRCNAM = DRILLM15 !
! X = 129.25515, 27.96976, 3.66, 34.260, 7.302325581, 3.37627907, 1.81E-06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-06,4.06E-04,7.64E-05,3.48E-05 !
! END !
! SRCNAM = DRILLM16 !
! X = 129.43307, 28.43668, 3.66, 33.208, 7.302325581, 3.37627907, 1.81E-06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-06,4.06E-04,7.64E-05,3.48E-05 !
! END !
! SRCNAM = DRILLM17 !
! X = 129.61098, 28.9036, 3.66, 32.115, 7.302325581, 3.37627907, 1.81E-06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-06,4.06E-04,7.64E-05,3.48E-05 !
! END !
! SRCNAM = DRILLM18 !
! X = 129.78888, 29.3705, 3.66, 31.054, 7.302325581, 3.37627907, 1.81E-06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-06,4.06E-04,7.64E-05,3.48E-05 !
! END !
! SRCNAM = DRILLM19 !
! X = 129.96679, 29.83741, 3.66, 30.022, 7.302325581, 3.37627907, 1.81E-06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-06,4.06E-04,7.64E-05,3.48E-05 !
! END !
! SRCNAM = DRILLM20 !
! X = 130.14468, 30.30431, 3.66, 29.022, 7.302325581, 3.37627907, 1.81E-06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-06,4.06E-04,7.64E-05,3.48E-05 !
! END !
! SRCNAM = DRILLM21 !
! X = 130.45329, 30.68139, 3.66, 28.271, 7.302325581, 3.37627907, 1.81E-06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-06,4.06E-04,7.64E-05,3.48E-05 !
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! END !
! SRCNAM = DRILLM22 !
! X = 130.82869, 31.00528, 3.66, 27.690, 7.302325581, 3.37627907, 1.81E-
06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-
06,4.06E-04,7.64E-05,3.48E-05 !
! END !
! SRCNAM = DRILLM23 !
! X = 131.11633, 31.4138, 3.66, 26.956, 7.302325581, 3.37627907, 1.81E-
06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-
06,4.06E-04,7.64E-05,3.48E-05 !
! END !
! SRCNAM = DRILLM24 !
! X = 131.40396, 31.82232, 3.66, 26.266, 7.302325581, 3.37627907, 1.81E-
06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-
06,4.06E-04,7.64E-05,3.48E-05 !
! END !
! SRCNAM = DRILLM25 !
! X = 131.72987, 32.19849, 3.66, 25.308, 7.302325581, 3.37627907, 1.81E-
06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-
06,4.06E-04,7.64E-05,3.48E-05 !
! END !
! SRCNAM = DRILLM26 !
! X = 132.08466, 32.55025, 3.66, 24.036, 7.302325581, 3.37627907, 1.81E-
06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-
06,4.06E-04,7.64E-05,3.48E-05 !
! END !
! SRCNAM = DRILLM27 !
! X = 132.4931, 32.83098, 3.66, 22.759, 7.302325581, 3.37627907, 1.81E-
06,7.46E-08,4.06E-04,0,3.08E-08,2.68E-05,7.64E-06,4.16E-05,1.81E-07,1.81E-
06,4.06E-04,7.64E-05,3.48E-05 !
! END !
! SRCNAM = FEROAD1 !
! X = 125.17384, 23.17569, 3.66, 33.292, 7.302325581, 3.38,
0.00E+00,3.42E-05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
! END !
! SRCNAM = FEROAD2 !
! X = 125.60973, 23.39549, 3.66, 33.494, 7.302325581, 3.38,
0.00E+00,3.42E-05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
! END !
! SRCNAM = FEROAD3 !
! X = 126.08181, 23.55943, 3.66, 33.704, 7.302325581, 3.38,
0.00E+00,3.42E-05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
! END !
! SRCNAM = FEROAD4 !
! X = 126.55388, 23.72337, 3.66, 33.905, 7.302325581, 3.38,
0.00E+00,3.42E-05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
! END !
! SRCNAM = FEROAD5 !
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! X = 127.02594, 23.88732, 3.66, 34.100, 7.302325581, 3.38,
0.00E+00,3.42E-05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
! END !
! SRCNAM = FEROAD6 !
! X = 127.498, 24.05127, 3.66, 34.289, 7.302325581, 3.38, 0.00E+00,3.42E-
05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
! END !
! SRCNAM = FEROAD7 !
! X = 127.92559, 24.29415, 3.66, 34.474, 7.302325581, 3.38,
0.00E+00,3.42E-05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
! END !
! SRCNAM = FEROAD8 !
! X = 128.27261, 24.65372, 3.66, 34.453, 7.302325581, 3.38,
0.00E+00,3.42E-05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
! END !
! SRCNAM = FEROAD9 !
! X = 128.53706, 25.0671, 3.66, 34.399, 7.302325581, 3.38, 0.00E+00,3.42E-
05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
! END !
! SRCNAM = FEROAD10 !
! X = 128.63575, 25.55697, 3.66, 34.384, 7.302325581, 3.38,
0.00E+00,3.42E-05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
! END !
! SRCNAM = FEROAD11 !
! X = 128.73444, 26.04682, 3.66, 34.369, 7.302325581, 3.38,
0.00E+00,3.42E-05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
! END !
! SRCNAM = FEROAD12 !
! X = 128.83312, 26.53667, 3.66, 34.353, 7.302325581, 3.38,
0.00E+00,3.42E-05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
! END !
! SRCNAM = FEROAD13 !
! X = 128.93181, 27.02652, 3.66, 34.335, 7.302325581, 3.38,
0.00E+00,3.42E-05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
! END !
! SRCNAM = FEROAD14 !
! X = 129.07723, 27.50284, 3.66, 34.303, 7.302325581, 3.38,
0.00E+00,3.42E-05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
! END !
! SRCNAM = FEROAD15 !
! X = 129.25515, 27.96976, 3.66, 34.260, 7.302325581, 3.38,
0.00E+00,3.42E-05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
! END !
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! SRCNAM = FEROAD16 !
! X = 129.43307, 28.43668, 3.66, 33.208, 7.302325581, 3.38,
0.00E+00,3.42E-05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
! END !
! SRCNAM = FEROAD17 !
! X = 129.61098, 28.9036, 3.66, 32.115, 7.302325581, 3.38, 0.00E+00,3.42E-
05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
! END !
! SRCNAM = FEROAD18 !
! X = 129.78888, 29.3705, 3.66, 31.054, 7.302325581, 3.38, 0.00E+00,3.42E-
05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
! END !
! SRCNAM = FEROAD19 !
! X = 129.96679, 29.83741, 3.66, 30.022, 7.302325581, 3.38,
0.00E+00,3.42E-05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
! END !
! SRCNAM = FEROAD20 !
! X = 130.14468, 30.30431, 3.66, 29.022, 7.302325581, 3.38,
0.00E+00,3.42E-05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
! END !
! SRCNAM = FEROAD21 !
! X = 130.45329, 30.68139, 3.66, 28.271, 7.302325581, 3.38,
0.00E+00,3.42E-05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
! END !
! SRCNAM = FEROAD22 !
! X = 130.82869, 31.00528, 3.66, 27.690, 7.302325581, 3.38,
0.00E+00,3.42E-05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
! END !
! SRCNAM = FEROAD23 !
! X = 131.11633, 31.4138, 3.66, 26.956, 7.302325581, 3.38, 0.00E+00,3.42E-
05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
! END !
! SRCNAM = FEROAD24 !
! X = 131.40396, 31.82232, 3.66, 26.266, 7.302325581, 3.38,
0.00E+00,3.42E-05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
! END !
! SRCNAM = FEROAD25 !
! X = 131.72987, 32.19849, 3.66, 25.308, 7.302325581, 3.38,
0.00E+00,3.42E-05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
! END !
! SRCNAM = FEROAD26 !
! X = 132.08466, 32.55025, 3.66, 24.036, 7.302325581, 3.38,
0.00E+00,3.42E-05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
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! END !
! SRCNAM = FEROAD27 !
! X = 132.4931, 32.83098, 3.66, 22.759, 7.302325581, 3.38, 0.00E+00,3.42E-
05,0.00E+00,0,1.27E-06,0.00E+00,2.90E-04,4.03E-02,4.14E-
03,0.00E+00,0.00E+00,4.48E-02,1.69E-02 !
! END !
! SRCNAM = FRACM1 !
! X = 125.17384, 23.17569, 3.66, 33.292, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
! SRCNAM = FRACM2 !
! X = 125.60973, 23.39549, 3.66, 33.494, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
! SRCNAM = FRACM3 !
! X = 126.08181, 23.55943, 3.66, 33.704, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
! SRCNAM = FRACM4 !
! X = 126.55388, 23.72337, 3.66, 33.905, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
! SRCNAM = FRACM5 !
! X = 127.02594, 23.88732, 3.66, 34.100, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
! SRCNAM = FRACM6 !
! X = 127.498, 24.05127, 3.66, 34.289, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
! SRCNAM = FRACM7 !
! X = 127.92559, 24.29415, 3.66, 34.474, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
! SRCNAM = FRACM8 !
! X = 128.27261, 24.65372, 3.66, 34.453, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
! SRCNAM = FRACM9 !
! X = 128.53706, 25.0671, 3.66, 34.399, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
! SRCNAM = FRACM10 !
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! X = 128.63575, 25.55697, 3.66, 34.384, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
! SRCNAM = FRACM11 !
! X = 128.73444, 26.04682, 3.66, 34.369, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
! SRCNAM = FRACM12 !
! X = 128.83312, 26.53667, 3.66, 34.353, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
! SRCNAM = FRACM13 !
! X = 128.93181, 27.02652, 3.66, 34.335, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
! SRCNAM = FRACM14 !
! X = 129.07723, 27.50284, 3.66, 34.303, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
! SRCNAM = FRACM15 !
! X = 129.25515, 27.96976, 3.66, 34.260, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
! SRCNAM = FRACM16 !
! X = 129.43307, 28.43668, 3.66, 33.208, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
! SRCNAM = FRACM17 !
! X = 129.61098, 28.9036, 3.66, 32.115, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
! SRCNAM = FRACM18 !
! X = 129.78888, 29.3705, 3.66, 31.054, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
! SRCNAM = FRACM19 !
! X = 129.96679, 29.83741, 3.66, 30.022, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
! SRCNAM = FRACM20 !
! X = 130.14468, 30.30431, 3.66, 29.022, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
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! SRCNAM = FRACM21 !
! X = 130.45329, 30.68139, 3.66, 28.271, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
! SRCNAM = FRACM22 !
! X = 130.82869, 31.00528, 3.66, 27.690, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
! SRCNAM = FRACM23 !
! X = 131.11633, 31.4138, 3.66, 26.956, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
! SRCNAM = FRACM24 !
! X = 131.40396, 31.82232, 3.66, 26.266, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
! SRCNAM = FRACM25 !
! X = 131.72987, 32.19849, 3.66, 25.308, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
! SRCNAM = FRACM26 !
! X = 132.08466, 32.55025, 3.66, 24.036, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
! SRCNAM = FRACM27 !
! X = 132.4931, 32.83098, 3.66, 22.759, 7.302325581, 3.37627907, 4.90E-
08,2.96E-07,1.55E-05,0,1.22E-07,1.07E-04,3.03E-05,1.38E-04,7.20E-07,4.90E-
08,1.55E-05,2.76E-04,1.38E-04 !
! END !
! SRCNAM = FRACFE1 !
! X = 125.17384, 23.17569, 3.66, 33.292, 7.302325581, 3.38,
0.00E+00,8.39E-06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
! END !
! SRCNAM = FRACFE2 !
! X = 125.60973, 23.39549, 3.66, 33.494, 7.302325581, 3.38,
0.00E+00,8.39E-06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
! END !
! SRCNAM = FRACFE3 !
! X = 126.08181, 23.55943, 3.66, 33.704, 7.302325581, 3.38,
0.00E+00,8.39E-06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
! END !
! SRCNAM = FRACFE4 !
! X = 126.55388, 23.72337, 3.66, 33.905, 7.302325581, 3.38,
0.00E+00,8.39E-06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
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! END !
! SRCNAM = FRACFE5 !
! X = 127.02594, 23.88732, 3.66, 34.100, 7.302325581, 3.38,
0.00E+00,8.39E-06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
! END !
! SRCNAM = FRACFE6 !
! X = 127.498, 24.05127, 3.66, 34.289, 7.302325581, 3.38, 0.00E+00,8.39E-
06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
! END !
! SRCNAM = FRACFE7 !
! X = 127.92559, 24.29415, 3.66, 34.474, 7.302325581, 3.38,
0.00E+00,8.39E-06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
! END !
! SRCNAM = FRACFE8 !
! X = 128.27261, 24.65372, 3.66, 34.453, 7.302325581, 3.38,
0.00E+00,8.39E-06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
! END !
! SRCNAM = FRACFE9 !
! X = 128.53706, 25.0671, 3.66, 34.399, 7.302325581, 3.38, 0.00E+00,8.39E-
06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
! END !
! SRCNAM = FRACFE10 !
! X = 128.63575, 25.55697, 3.66, 34.384, 7.302325581, 3.38,
0.00E+00,8.39E-06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
! END !
! SRCNAM = FRACFE11 !
! X = 128.73444, 26.04682, 3.66, 34.369, 7.302325581, 3.38,
0.00E+00,8.39E-06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
! END !
! SRCNAM = FRACFE12 !
! X = 128.83312, 26.53667, 3.66, 34.353, 7.302325581, 3.38,
0.00E+00,8.39E-06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
! END !
! SRCNAM = FRACFE13 !
! X = 128.93181, 27.02652, 3.66, 34.335, 7.302325581, 3.38,
0.00E+00,8.39E-06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
! END !
! SRCNAM = FRACFE14 !
! X = 129.07723, 27.50284, 3.66, 34.303, 7.302325581, 3.38,
0.00E+00,8.39E-06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
! END !
! SRCNAM = FRACFE15 !
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! X = 129.25515, 27.96976, 3.66, 34.260, 7.302325581, 3.38,
0.00E+00,8.39E-06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
! END !
! SRCNAM = FRACFE16 !
! X = 129.43307, 28.43668, 3.66, 33.208, 7.302325581, 3.38,
0.00E+00,8.39E-06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
! END !
! SRCNAM = FRACFE17 !
! X = 129.61098, 28.9036, 3.66, 32.115, 7.302325581, 3.38, 0.00E+00,8.39E-
06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
! END !
! SRCNAM = FRACFE18 !
! X = 129.78888, 29.3705, 3.66, 31.054, 7.302325581, 3.38, 0.00E+00,8.39E-
06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
! END !
! SRCNAM = FRACFE19 !
! X = 129.96679, 29.83741, 3.66, 30.022, 7.302325581, 3.38,
0.00E+00,8.39E-06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
! END !
! SRCNAM = FRACFE20 !
! X = 130.14468, 30.30431, 3.66, 29.022, 7.302325581, 3.38,
0.00E+00,8.39E-06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
! END !
! SRCNAM = FRACFE21 !
! X = 130.45329, 30.68139, 3.66, 28.271, 7.302325581, 3.38,
0.00E+00,8.39E-06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
! END !
! SRCNAM = FRACFE22 !
! X = 130.82869, 31.00528, 3.66, 27.690, 7.302325581, 3.38,
0.00E+00,8.39E-06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
! END !
! SRCNAM = FRACFE23 !
! X = 131.11633, 31.4138, 3.66, 26.956, 7.302325581, 3.38, 0.00E+00,8.39E-
06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
! END !
! SRCNAM = FRACFE24 !
! X = 131.40396, 31.82232, 3.66, 26.266, 7.302325581, 3.38,
0.00E+00,8.39E-06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
! END !
! SRCNAM = FRACFE25 !
! X = 131.72987, 32.19849, 3.66, 25.308, 7.302325581, 3.38,
0.00E+00,8.39E-06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
! END !
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! SRCNAM = FRACFE26 !
! X = 132.08466, 32.55025, 3.66, 24.036, 7.302325581, 3.38,
0.00E+00,8.39E-06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
! END !
! SRCNAM = FRACFE27 !
! X = 132.4931, 32.83098, 3.66, 22.759, 7.302325581, 3.38, 0.00E+00,8.39E-
06,0.00E+00,0,3.11E-07,0.00E+00,7.11E-05,6.22E-03,1.02E-
03,0.00E+00,0.00E+00,7.32E-03,1.10E-03 !
! END !
! SRCNAM = OPSTAIL1 !
! X = 125.17384, 23.17569, 3.66, 33.292, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
! END !
! SRCNAM = OPSTAIL2 !
! X = 125.60973, 23.39549, 3.66, 33.494, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
! END !
! SRCNAM = OPSTAIL3 !
! X = 126.08181, 23.55943, 3.66, 33.704, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
! END !
! SRCNAM = OPSTAIL4 !
! X = 126.55388, 23.72337, 3.66, 33.905, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
! END !
! SRCNAM = OPSTAIL5 !
! X = 127.02594, 23.88732, 3.66, 34.100, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
! END !
! SRCNAM = OPSTAIL6 !
! X = 127.498, 24.05127, 3.66, 34.289, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
! END !
! SRCNAM = OPSTAIL7 !
! X = 127.92559, 24.29415, 3.66, 34.474, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
! END !
! SRCNAM = OPSTAIL8 !
! X = 128.27261, 24.65372, 3.66, 34.453, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
! END !
! SRCNAM = OPSTAIL9 !
! X = 128.53706, 25.0671, 3.66, 34.399, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
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! END !
! SRCNAM = OPSTAIL10 !
! X = 128.63575, 25.55697, 3.66, 34.384, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
! END !
! SRCNAM = OPSTAIL11 !
! X = 128.73444, 26.04682, 3.66, 34.369, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
! END !
! SRCNAM = OPSTAIL12 !
! X = 128.83312, 26.53667, 3.66, 34.353, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
! END !
! SRCNAM = OPSTAIL13 !
! X = 128.93181, 27.02652, 3.66, 34.335, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
! END !
! SRCNAM = OPSTAIL14 !
! X = 129.07723, 27.50284, 3.66, 34.303, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
! END !
! SRCNAM = OPSTAIL15 !
! X = 129.25515, 27.96976, 3.66, 34.260, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
! END !
! SRCNAM = OPSTAIL16 !
! X = 129.43307, 28.43668, 3.66, 33.208, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
! END !
! SRCNAM = OPSTAIL17 !
! X = 129.61098, 28.9036, 3.66, 32.115, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
! END !
! SRCNAM = OPSTAIL18 !
! X = 129.78888, 29.3705, 3.66, 31.054, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
! END !
! SRCNAM = OPSTAIL19 !
! X = 129.96679, 29.83741, 3.66, 30.022, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
! END !
! SRCNAM = OPSTAIL20 !
```

```
! X = 130.14468, 30.30431, 3.66, 29.022, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
! END !
! SRCNAM = OPSTAIL21 !
! X = 130.45329, 30.68139, 3.66, 28.271, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
! END !
! SRCNAM = OPSTAIL22 !
! X = 130.82869, 31.00528, 3.66, 27.690, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
! END !
! SRCNAM = OPSTAIL23 !
! X = 131.11633, 31.4138, 3.66, 26.956, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
! END !
! SRCNAM = OPSTAIL24 !
! X = 131.40396, 31.82232, 3.66, 26.266, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
! END !
! SRCNAM = OPSTAIL25 !
! X = 131.72987, 32.19849, 3.66, 25.308, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
! END !
! SRCNAM = OPSTAIL26 !
! X = 132.08466, 32.55025, 3.66, 24.036, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
! END !
! SRCNAM = OPSTAIL27 !
! X = 132.4931, 32.83098, 3.66, 22.759, 7.302325581, 3.37627907, 9.30E-
08,3.24E-09,2.86E-05,0,1.34E-09,1.17E-06,3.32E-07,1.68E-06,7.88E-09,9.30E-
08,2.86E-05,3.19E-06,1.51E-06 !
! END !
! SRCNAM = GRVLNRRD1 !
! X = 125.17384, 23.17569, 3.66, 33.292, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
! END !
! SRCNAM = GRVLNRRD2 !
! X = 125.60973, 23.39549, 3.66, 33.494, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
! END !
! SRCNAM = GRVLNRRD3 !
! X = 126.08181, 23.55943, 3.66, 33.704, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
! END !
! SRCNAM = GRVLNRRD4 !
! X = 126.55388, 23.72337, 3.66, 33.905, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
```

```
! END !
! SRCNAM = GRVLNRRD5 !
! X = 127.02594, 23.88732, 3.66, 34.100, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
! END !
! SRCNAM = GRVLNRRD6 !
! X = 127.498, 24.05127, 3.66, 34.289, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
! END !
! SRCNAM = GRVLNRRD7 !
! X = 127.92559, 24.29415, 3.66, 34.474, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
! END !
! SRCNAM = GRVLNRRD8 !
! X = 128.27261, 24.65372, 3.66, 34.453, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
! END !
! SRCNAM = GRVLNRRD9 !
! X = 128.53706, 25.0671, 3.66, 34.399, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
! END !
! SRCNAM = GRVLNRRD10 !
! X = 128.63575, 25.55697, 3.66, 34.384, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
! END !
! SRCNAM = GRVLNRRD11 !
! X = 128.73444, 26.04682, 3.66, 34.369, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
! END !
! SRCNAM = GRVLNRRD12 !
! X = 128.83312, 26.53667, 3.66, 34.353, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
! END !
! SRCNAM = GRVLNRRD13 !
! X = 128.93181, 27.02652, 3.66, 34.335, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
! END !
! SRCNAM = GRVLNRRD14 !
! X = 129.07723, 27.50284, 3.66, 34.303, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
! END !
! SRCNAM = GRVLNRRD15 !
! X = 129.25515, 27.96976, 3.66, 34.260, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
! END !
! SRCNAM = GRVLNRRD16 !
! X = 129.43307, 28.43668, 3.66, 33.208, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
! END !
! SRCNAM = GRVLNRRD17 !
! X = 129.61098, 28.9036, 3.66, 32.115, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
! END !
! SRCNAM = GRVLNRRD18 !
```

```
! X = 129.78888, 29.3705, 3.66, 31.054, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
! END !
! SRCNAM = GRVLNRRD19 !
! X = 129.96679, 29.83741, 3.66, 30.022, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
! END !
! SRCNAM = GRVLNRRD20 !
! X = 130.14468, 30.30431, 3.66, 29.022, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
! END !
! SRCNAM = GRVLNRRD21 !
! X = 130.45329, 30.68139, 3.66, 28.271, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
! END !
! SRCNAM = GRVLNRRD22 !
! X = 130.82869, 31.00528, 3.66, 27.690, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
! END !
! SRCNAM = GRVLNRRD23 !
! X = 131.11633, 31.4138, 3.66, 26.956, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
! END !
! SRCNAM = GRVLNRRD24 !
! X = 131.40396, 31.82232, 3.66, 26.266, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
! END !
! SRCNAM = GRVLNRRD25 !
! X = 131.72987, 32.19849, 3.66, 25.308, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
! END !
! SRCNAM = GRVLNRRD26 !
! X = 132.08466, 32.55025, 3.66, 24.036, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
! END !
! SRCNAM = GRVLNRRD27 !
! X = 132.4931, 32.83098, 3.66, 22.759, 7.3, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.001057227 !
! END !
! SRCNAM = S1CONTAIL1 !
! X = 125.17384, 23.17569, 3.66, 33.292, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
! END !
! SRCNAM = S1CONTAIL2 !
! X = 125.60973, 23.39549, 3.66, 33.494, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
! END !
! SRCNAM = S1CONTAIL3 !
! X = 126.08181, 23.55943, 3.66, 33.704, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
! END !
! SRCNAM = S1CONTAIL4 !
! X = 126.55388, 23.72337, 3.66, 33.905, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
```

```
! END !
! SRCNAM = S1CONTAIL5 !
! X = 127.02594, 23.88732, 3.66, 34.100, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
! END !
! SRCNAM = S1CONTAIL6 !
! X = 127.498, 24.05127, 3.66, 34.289, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
! END !
! SRCNAM = S1CONTAIL7 !
! X = 127.92559, 24.29415, 3.66, 34.474, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
! END !
! SRCNAM = S1CONTAIL8 !
! X = 128.27261, 24.65372, 3.66, 34.453, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
! END !
! SRCNAM = S1CONTAIL9 !
! X = 128.53706, 25.0671, 3.66, 34.399, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
! END !
! SRCNAM = S1CONTAIL10 !
! X = 128.63575, 25.55697, 3.66, 34.384, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
! END !
! SRCNAM = S1CONTAIL11 !
! X = 128.73444, 26.04682, 3.66, 34.369, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
! END !
! SRCNAM = S1CONTAIL12 !
! X = 128.83312, 26.53667, 3.66, 34.353, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
! END !
! SRCNAM = S1CONTAIL13 !
! X = 128.93181, 27.02652, 3.66, 34.335, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
! END !
! SRCNAM = S1CONTAIL14 !
! X = 129.07723, 27.50284, 3.66, 34.303, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
! END !
! SRCNAM = S1CONTAIL15 !
! X = 129.25515, 27.96976, 3.66, 34.260, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
! END !
! SRCNAM = S1CONTAIL16 !
! X = 129.43307, 28.43668, 3.66, 33.208, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
! END !
! SRCNAM = S1CONTAIL17 !
! X = 129.61098, 28.9036, 3.66, 32.115, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
! END !
! SRCNAM = S1CONTAIL18 !
```

```
! X = 129.78888, 29.3705, 3.66, 31.054, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
! END !
! SRCNAM = S1CONTAIL19 !
! X = 129.96679, 29.83741, 3.66, 30.022, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
! END !
! SRCNAM = S1CONTAIL20 !
! X = 130.14468, 30.30431, 3.66, 29.022, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
! END !
! SRCNAM = S1CONTAIL21 !
! X = 130.45329, 30.68139, 3.66, 28.271, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
! END !
! SRCNAM = S1CONTAIL22 !
! X = 130.82869, 31.00528, 3.66, 27.690, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
! END !
! SRCNAM = S1CONTAIL23 !
! X = 131.11633, 31.4138, 3.66, 26.956, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
! END !
! SRCNAM = S1CONTAIL24 !
! X = 131.40396, 31.82232, 3.66, 26.266, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
! END !
! SRCNAM = S1CONTAIL25 !
! X = 131.72987, 32.19849, 3.66, 25.308, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
! END !
! SRCNAM = S1CONTAIL26 !
! X = 132.08466, 32.55025, 3.66, 24.036, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
! END !
! SRCNAM = S1CONTAIL27 !
! X = 132.4931, 32.83098, 3.66, 22.759, 7.302325581, 3.37627907,
0,0,0,0,0,0,0,0,0,0,0,0,0.000626798 !
! END !
```

----

[a] Data for each source are treated as a separate input subgroup and therefore must end with an input group terminator.

[b] An emission rate must be entered for every pollutant modeled. Enter emission rate of zero for secondary pollutants that are modeled, but not emitted. Units are specified by IVLU (e.g. 1 for g/s).

Subgroup (16c)

```
                                          a
       VOLUME SOURCE: VARIABLE EMISSIONS DATA
       ----------------------------------------

    Use this subgroup to describe temporal variations in the emission
    rates given in 16b.  Factors entered multiply the rates in 16b.
    Skip sources here that have constant emissions.  For more elaborate
    variation in source parameters, use VOLEMARB.DAT and NVL2 > 0.

    IVARY determines the type of variation, and is source-specific:
    (IVARY)                              Default: 0
         0 =       Constant
         1 =       Diurnal cycle (24 scaling factors: hours 1-24)
         2 =       Monthly cycle (12 scaling factors: months 1-12)
         3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                                  where first group is DEC-JAN-FEB)
         4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                                  first group is Stability Class A,
                                  and the speed classes have upper
                                  bounds (m/s) defined in Group 12
         5 =       Temperature   (12 scaling factors, where temperature
                                  classes have upper bounds (C) of:
                                  0, 5, 10, 15, 20, 25, 30, 35, 40,
                                  45, 50, 50+)


--------
    a
     Data for each species are treated as a separate input subgroup
     and therefore must end with an input group terminator.

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INPUT GROUPS: 17a & 17b -- Non-gridded (discrete) receptor information
-----------------------

---------------
Subgroup (17a)
---------------

     Number of non-gridded receptors (NREC)  No default  !  NREC = 269 !

!END!

---------------
Subgroup (17b)
---------------
                                          a
           NON-GRIDDED (DISCRETE) RECEPTOR DATA
           ------------------------------------
```

Receptor No.	X UTM Coordinate (km)	Y UTM Coordinate (km)	Ground Elevation (m)	Height Above Ground (m) [b]
00001 ! X =	289.802,	-137.751,	1039.1,	0 ! !END! anwr-0001
00002 ! X =	294.117,	-127.757,	991.9,	0 ! !END! anwr-0002
00003 ! X =	296.471,	-117.762,	1076.1,	0 ! !END! anwr-0003
00004 ! X =	310.194,	-107.773,	1042.8,	0 ! !END! anwr-0004
00005 ! X =	315.251,	-97.778,	747.2,	0 ! !END! anwr-0005
00006 ! X =	322.899,	-87.785,	1140.7,	0 ! !END! anwr-0006
00007 ! X =	377.995,	-67.826,	1328.8,	0 ! !END! anwr-0007
00008 ! X =	382.380,	-57.830,	1298.0,	0 ! !END! anwr-0008
00009 ! X =	383.033,	-47.834,	1642.3,	0 ! !END! anwr-0009
00010 ! X =	381.515,	-37.835,	1079.6,	0 ! !END! anwr-0010
00011 ! X =	377.114,	-27.834,	959.8,	0 ! !END! anwr-0011
00012 ! X =	368.689,	-17.830,	858.4,	0 ! !END! anwr-0012
00013 ! X =	368.630,	-7.831,	572.4,	0 ! !END! anwr-0013
00014 ! X =	275.946,	-147.740,	1203.0,	0 ! !END! anwr-0014
00015 ! X =	277.053,	-137.745,	783.4,	0 ! !END! anwr-0015
00016 ! X =	283.689,	-127.752,	877.2,	0 ! !END! anwr-0016
00017 ! X =	284.617,	-117.756,	884.0,	0 ! !END! anwr-0017
00018 ! X =	294.480,	-107.765,	955.3,	0 ! !END! anwr-0018
00019 ! X =	304.570,	-97.772,	956.1,	0 ! !END! anwr-0019
00020 ! X =	309.651,	-87.778,	899.4,	0 ! !END! anwr-0020
00021 ! X =	317.624,	-77.786,	764.8,	0 ! !END! anwr-0021
00022 ! X =	371.920,	-57.824,	1238.2,	0 ! !END! anwr-0022
00023 ! X =	372.907,	-47.827,	1406.8,	0 ! !END! anwr-0023
00024 ! X =	371.043,	-37.827,	889.6,	0 ! !END! anwr-0024
00025 ! X =	363.719,	-27.825,	892.9,	0 ! !END! anwr-0025
00026 ! X =	358.458,	-17.823,	772.9,	0 ! !END! anwr-0026
00027 ! X =	358.358,	-7.824,	447.3,	0 ! !END! anwr-0027
00028 ! X =	355.055,	2.177,	236.5,	0 ! !END! anwr-0028
00029 ! X =	263.629,	-157.731,	1492.5,	0 ! !END! anwr-0029
00030 ! X =	265.853,	-147.736,	1135.1,	0 ! !END! anwr-0030
00031 ! X =	264.819,	-137.739,	820.5,	0 ! !END! anwr-0031
00032 ! X =	272.229,	-127.746,	922.9,	0 ! !END! anwr-0032
00033 ! X =	274.516,	-117.751,	679.9,	0 ! !END! anwr-0033
00034 ! X =	273.435,	-107.754,	649.5,	0 ! !END! anwr-0034
00035 ! X =	291.918,	-97.766,	832.1,	0 ! !END! anwr-0035
00036 ! X =	296.625,	-87.771,	593.2,	0 ! !END! anwr-0036
00037 ! X =	303.394,	-77.778,	851.4,	0 ! !END! anwr-0037
00038 ! X =	309.919,	-67.784,	781.4,	0 ! !END! anwr-0038
00039 ! X =	360.349,	-57.816,	746.5,	0 ! !END! anwr-0039
00040 ! X =	362.620,	-47.820,	1054.0,	0 ! !END! anwr-0040
00041 ! X =	359.486,	-37.821,	636.2,	0 ! !END! anwr-0041
00042 ! X =	349.308,	-27.816,	749.2,	0 ! !END! anwr-0042
00043 ! X =	347.936,	-17.816,	541.9,	0 ! !END! anwr-0043
00044 ! X =	347.930,	-7.818,	348.5,	0 ! !END! anwr-0044
00045 ! X =	342.858,	2.184,	250.6,	0 ! !END! anwr-0045
00046 ! X =	339.156,	12.185,	131.1,	0 ! !END! anwr-0046
00047 ! X =	238.438,	-167.715,	1462.9,	0 ! !END! anwr-0047
00048 ! X =	255.761,	-147.731,	1178.4,	0 ! !END! anwr-0048
00049 ! X =	254.727,	-137.735,	864.5,	0 ! !END! anwr-0049
00050 ! X =	259.013,	-127.740,	578.4,	0 ! !END! anwr-0050

```
00051 ! X =   264.417,  -117.745,    610.5,    0 ! !END! anwr-0051
00052 ! X =   263.341,  -107.749,    528.0,    0 ! !END! anwr-0052
00053 ! X =   262.277,   -97.751,    491.0,    0 ! !END! anwr-0053
00054 ! X =   286.107,   -87.766,    443.2,    0 ! !END! anwr-0054
00055 ! X =   291.381,   -77.772,    767.6,    0 ! !END! anwr-0055
00056 ! X =   299.822,   -67.778,    768.0,    0 ! !END! anwr-0056
00057 ! X =   306.567,   -57.784,    665.4,    0 ! !END! anwr-0057
00058 ! X =   351.042,   -47.813,    571.6,    0 ! !END! anwr-0058
00059 ! X =   343.064,   -37.810,    343.3,    0 ! !END! anwr-0059
00060 ! X =   339.164,   -27.810,    400.0,    0 ! !END! anwr-0060
00061 ! X =   337.386,   -17.810,    256.4,    0 ! !END! anwr-0061
00062 ! X =   337.620,    -7.812,    253.1,    0 ! !END! anwr-0062
00063 ! X =   328.260,     2.193,    172.8,    0 ! !END! anwr-0063
00064 ! X =   328.844,    12.191,    117.5,    0 ! !END! anwr-0064
00065 ! X =   332.217,    22.188,     62.3,    0 ! !END! anwr-0065
00066 ! X =   316.267,  -187.744,   1151.1,    0 ! !END! anwr-0066
00067 ! X =   313.493,  -177.747,   1252.8,    0 ! !END! anwr-0067
00068 ! X =   310.454,  -167.751,   1052.1,    0 ! !END! anwr-0068
00069 ! X =   302.316,  -157.750,   1442.6,    0 ! !END! anwr-0069
00070 ! X =   286.039,  -147.745,   1104.7,    0 ! !END! anwr-0070
00071 ! X =   289.892,  -137.612,   1037.2,    0 ! !END! anwr-0071
00072 ! X =   309.900,  -108.152,   1047.1,    0 ! !END! anwr-0072
00073 ! X =   309.868,  -166.625,   1116.8,    0 ! !END! anwr-0073
00074 ! X =   329.908,   -85.087,   1125.6,    0 ! !END! anwr-0074
00075 ! X =   339.906,   -83.704,   1518.9,    0 ! !END! anwr-0075
00076 ! X =   349.904,   -82.301,   1139.5,    0 ! !END! anwr-0076
00077 ! X =   359.902,   -80.673,   1412.6,    0 ! !END! anwr-0077
00078 ! X =   369.902,   -76.002,   1058.3,    0 ! !END! anwr-0078
00079 ! X =   307.165,  -197.735,   1014.7,    0 ! !END! anwr-0079
00080 ! X =   305.718,  -187.739,   1145.9,    0 ! !END! anwr-0080
00081 ! X =   303.339,  -177.743,   1398.8,    0 ! !END! anwr-0081
00082 ! X =   298.362,  -167.744,   1497.8,    0 ! !END! anwr-0082
00083 ! X =   275.050,  -157.736,   1565.0,    0 ! !END! anwr-0083
00084 ! X =   357.638,    12.173,    170.6,    0 ! !END! anwr-0084
00085 ! X =   349.840,    12.179,    166.3,    0 ! !END! anwr-0085
00086 ! X =   289.879,  -161.964,   1436.1,    0 ! !END! anwr-0086
00087 ! X =   319.915,   -76.272,    726.5,    0 ! !END! anwr-0087
00088 ! X =   319.841,  -206.622,   1087.2,    0 ! !END! anwr-0088
00089 ! X =   329.914,   -74.967,    968.7,    0 ! !END! anwr-0089
00090 ! X =   339.912,   -73.571,   1280.0,    0 ! !END! anwr-0090
00091 ! X =   349.963,    12.422,    163.2,    0 ! !END! anwr-0091
00092 ! X =   349.910,   -72.140,   1172.0,    0 ! !END! anwr-0092
00093 ! X =   359.960,    10.707,    191.8,    0 ! !END! anwr-0093
00094 ! X =   359.909,   -70.129,    937.7,    0 ! !END! anwr-0094
00095 ! X =   369.958,     8.238,    231.3,    0 ! !END! anwr-0095
00096 ! X =   319.153,  -217.731,   1067.3,    0 ! !END! anwr-0096
00097 ! X =   297.049,  -197.730,   1325.9,    0 ! !END! anwr-0097
00098 ! X =   295.392,  -187.733,   1076.2,    0 ! !END! anwr-0098
00099 ! X =   292.956,  -177.737,   1194.2,    0 ! !END! anwr-0099
00100 ! X =   255.830,  -177.718,   1072.1,    0 ! !END! anwr-0100
00101 ! X =   247.706,  -177.715,   1435.1,    0 ! !END! anwr-0101
00102 ! X =   248.518,  -167.720,   1178.1,    0 ! !END! anwr-0102
00103 ! X =   361.603,    22.170,     64.8,    0 ! !END! anwr-0103
00104 ! X =   343.183,    22.182,     48.5,    0 ! !END! anwr-0104
```

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00105 ! X =    249.896,   -161.786,     1271.9,      0 ! !END! anwr-0105
00106 ! X =    259.892,   -160.380,     1227.4,      0 ! !END! anwr-0106
00107 ! X =    269.884,   -168.722,     1582.4,      0 ! !END! anwr-0107
00108 ! X =    279.914,   -100.278,      661.6,      0 ! !END! anwr-0108
00109 ! X =    279.879,   -170.482,     1754.5,      0 ! !END! anwr-0109
00110 ! X =    299.850,   -208.159,     1075.1,      0 ! !END! anwr-0110
00111 ! X =    309.922,    -67.865,      782.0,      0 ! !END! anwr-0111
00112 ! X =    319.921,    -66.148,     1034.1,      0 ! !END! anwr-0112
00113 ! X =    319.835,   -218.372,     1063.4,      0 ! !END! anwr-0113
00114 ! X =    329.919,    -64.828,      903.1,      0 ! !END! anwr-0114
00115 ! X =    339.918,    -63.450,     1283.3,      0 ! !END! anwr-0115
00116 ! X =    349.972,     26.638,       22.2,      0 ! !END! anwr-0116
00117 ! X =    349.916,    -61.988,     1204.3,      0 ! !END! anwr-0117
00118 ! X =    359.916,    -58.250,      708.2,      0 ! !END! anwr-0118
00119 ! X =    369.964,     18.275,      134.1,      0 ! !END! anwr-0119
00120 ! X =    286.119,   -207.718,     1203.4,      0 ! !END! anwr-0120
00121 ! X =    285.656,   -197.724,     1450.8,      0 ! !END! anwr-0121
00122 ! X =    281.299,   -187.726,     1529.0,      0 ! !END! anwr-0122
00123 ! X =    261.131,   -187.717,     1381.3,      0 ! !END! anwr-0123
00124 ! X =    237.626,   -177.710,     1583.6,      0 ! !END! anwr-0124
00125 ! X =    337.125,     32.185,       19.6,      0 ! !END! anwr-0125
00126 ! X =    229.906,   -157.662,     1015.7,      0 ! !END! anwr-0126
00127 ! X =    229.905,   -160.094,      967.2,      0 ! !END! anwr-0127
00128 ! X =    239.904,   -152.694,      868.1,      0 ! !END! anwr-0128
00129 ! X =    239.887,   -191.765,     1590.3,      0 ! !END! anwr-0129
00130 ! X =    249.900,   -151.685,      959.9,      0 ! !END! anwr-0130
00131 ! X =    249.882,   -192.757,     1590.9,      0 ! !END! anwr-0131
00132 ! X =    259.880,   -187.926,     1396.6,      0 ! !END! anwr-0132
00133 ! X =    269.921,    -91.330,      481.7,      0 ! !END! anwr-0133
00134 ! X =    269.879,   -179.654,     1693.4,      0 ! !END! anwr-0134
00135 ! X =    279.919,    -90.216,      384.0,      0 ! !END! anwr-0135
00136 ! X =    279.874,   -181.391,     1599.2,      0 ! !END! anwr-0136
00137 ! X =    299.845,   -218.353,      893.7,      0 ! !END! anwr-0137
00138 ! X =    309.931,    -52.455,      611.4,      0 ! !END! anwr-0138
00139 ! X =    319.927,    -56.023,      823.2,      0 ! !END! anwr-0139
00140 ! X =    329.925,    -54.710,      877.4,      0 ! !END! anwr-0140
00141 ! X =    339.981,     41.158,        2.4,      0 ! !END! anwr-0141
00142 ! X =    339.924,    -53.291,      795.5,      0 ! !END! anwr-0142
00143 ! X =    349.981,     41.002,        1.4,      0 ! !END! anwr-0143
00144 ! X =    349.922,    -51.865,      586.9,      0 ! !END! anwr-0144
00145 ! X =    359.977,     36.429,        0.2,      0 ! !END! anwr-0145
00146 ! X =    369.973,     31.666,        3.4,      0 ! !END! anwr-0146
00147 ! X =     19.990,   -206.149,     1337.5,      0 ! !END! gaar-0001
00148 ! X =     29.986,   -201.575,     1115.3,      0 ! !END! gaar-0002
00149 ! X =     39.981,   -199.984,      959.9,      0 ! !END! gaar-0003
00150 ! X =    -39.978,   -233.576,      919.0,      0 ! !END! gaar-0004
00151 ! X =    -29.983,   -235.721,     1107.9,      0 ! !END! gaar-0005
00152 ! X =    -19.989,   -234.467,     1152.9,      0 ! !END! gaar-0006
00153 ! X =     -9.995,   -196.684,     1212.5,      0 ! !END! gaar-0007
00154 ! X =      0.000,   -196.703,     1523.4,      0 ! !END! gaar-0008
00155 ! X =      9.995,   -196.683,     1604.4,      0 ! !END! gaar-0009
00156 ! X =     19.990,   -195.541,     1488.6,      0 ! !END! gaar-0010
00157 ! X =     29.986,   -191.278,     1393.6,      0 ! !END! gaar-0011
00158 ! X =     39.981,   -189.955,      664.3,      0 ! !END! gaar-0012
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00159 ! X =    49.977,   -189.778,     1440.1,     0 ! !END! gaar-0013
00160 ! X =    59.972,   -188.698,     1536.5,     0 ! !END! gaar-0014
00161 ! X =   -49.974,   -223.489,      866.4,     0 ! !END! gaar-0015
00162 ! X =   -39.979,   -220.660,      936.8,     0 ! !END! gaar-0016
00163 ! X =   -29.984,   -225.135,      962.3,     0 ! !END! gaar-0017
00164 ! X =   -19.991,   -181.840,      799.2,     0 ! !END! gaar-0018
00165 ! X =    -9.996,   -186.657,      990.3,     0 ! !END! gaar-0019
00166 ! X =     0.000,   -186.676,     1072.3,     0 ! !END! gaar-0020
00167 ! X =     9.996,   -186.656,     1245.9,     0 ! !END! gaar-0021
00168 ! X =    19.991,   -181.838,     1131.4,     0 ! !END! gaar-0022
00169 ! X =    29.987,   -180.065,      821.2,     0 ! !END! gaar-0023
00170 ! X =    39.982,   -179.927,      592.1,     0 ! !END! gaar-0024
00171 ! X =    49.978,   -179.749,      973.3,     0 ! !END! gaar-0025
00172 ! X =    59.974,   -173.093,      774.8,     0 ! !END! gaar-0026
00173 ! X =    69.970,   -168.008,      680.2,     0 ! !END! gaar-0027
00174 ! X =    79.966,   -167.710,      795.4,     0 ! !END! gaar-0028
00175 ! X =   179.919,   -181.907,     1297.2,     0 ! !END! gaar-0029
00176 ! X =     4.117,   -227.636,      973.3,     0 ! !END! gaar-0030
00177 ! X =     4.261,   -217.641,     1064.3,     0 ! !END! gaar-0031
00178 ! X =     9.995,   -216.738,     1072.1,     0 ! !END! gaar-0032
00179 ! X =    19.990,   -216.353,      748.3,     0 ! !END! gaar-0033
00180 ! X =    29.985,   -212.932,      780.8,     0 ! !END! gaar-0034
00181 ! X =    39.980,   -210.014,      835.4,     0 ! !END! gaar-0035
00182 ! X =    49.975,   -209.838,     1110.4,     0 ! !END! gaar-0036
00183 ! X =    59.970,   -209.395,     1151.6,     0 ! !END! gaar-0037
00184 ! X =    69.965,   -206.117,     1250.0,     0 ! !END! gaar-0038
00185 ! X =    79.960,   -209.737,     1079.5,     0 ! !END! gaar-0039
00186 ! X =    89.955,   -211.878,     1236.0,     0 ! !END! gaar-0040
00187 ! X =    99.949,   -215.463,     1059.4,     0 ! !END! gaar-0041
00188 ! X =   109.943,   -218.715,      970.2,     0 ! !END! gaar-0042
00189 ! X =   119.938,   -218.795,      783.5,     0 ! !END! gaar-0043
00190 ! X =   129.932,   -219.510,     1270.5,     0 ! !END! gaar-0044
00191 ! X =   139.927,   -219.397,     1188.9,     0 ! !END! gaar-0045
00192 ! X =   149.922,   -218.834,     1246.0,     0 ! !END! gaar-0046
00193 ! X =   159.917,   -218.232,     1387.5,     0 ! !END! gaar-0047
00194 ! X =   169.913,   -216.946,     1182.3,     0 ! !END! gaar-0048
00195 ! X =   179.909,   -212.073,     1502.5,     0 ! !END! gaar-0049
00196 ! X =    -5.939,   -227.635,     1031.6,     0 ! !END! gaar-0050
00197 ! X =    -5.777,   -217.641,     1171.0,     0 ! !END! gaar-0051
00198 ! X =   192.384,   -207.679,     1384.0,     0 ! !END! gaar-0052
00199 ! X =    -5.649,   -207.646,     1450.8,     0 ! !END! gaar-0053
00200 ! X =     0.000,   -206.730,     1318.9,     0 ! !END! gaar-0054
00201 ! X =     9.995,   -206.712,     1310.5,     0 ! !END! gaar-0055
00202 ! X =    49.976,   -199.809,     1537.8,     0 ! !END! gaar-0056
00203 ! X =    59.971,   -199.219,     1430.2,     0 ! !END! gaar-0057
00204 ! X =    69.967,   -193.724,     1181.4,     0 ! !END! gaar-0058
00205 ! X =    79.961,   -198.459,     1147.4,     0 ! !END! gaar-0059
00206 ! X =    89.956,   -201.832,     1113.0,     0 ! !END! gaar-0060
00207 ! X =    99.951,   -203.092,     1384.5,     0 ! !END! gaar-0061
00208 ! X =   109.945,   -208.542,     1256.3,     0 ! !END! gaar-0062
00209 ! X =   119.940,   -208.755,      936.5,     0 ! !END! gaar-0063
00210 ! X =   129.935,   -209.393,      927.7,     0 ! !END! gaar-0064
00211 ! X =   139.930,   -209.353,     1184.2,     0 ! !END! gaar-0065
00212 ! X =   149.925,   -208.788,     1093.9,     0 ! !END! gaar-0066
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00213 ! X =   159.920,   -208.183,    1256.2,    0 ! !END! gaar-0067
00214 ! X =   169.916,   -206.342,    1250.1,    0 ! !END! gaar-0068
00215 ! X =   179.912,   -202.018,    1586.2,    0 ! !END! gaar-0069
00216 ! X =   189.907,   -201.294,    1370.6,    0 ! !END! gaar-0070
00217 ! X =   -16.007,   -227.636,    1022.2,    0 ! !END! gaar-0071
00218 ! X =   -15.815,   -217.641,    1147.5,    0 ! !END! gaar-0072
00219 ! X =   202.945,   -207.683,    1536.5,    0 ! !END! gaar-0073
00220 ! X =   -15.687,   -207.646,    1177.2,    0 ! !END! gaar-0074
00221 ! X =   202.698,   -197.688,    1403.9,    0 ! !END! gaar-0075
00222 ! X =   109.218,   -197.662,    1332.1,    0 ! !END! gaar-0076
00223 ! X =   -15.560,   -197.652,    1231.8,    0 ! !END! gaar-0077
00224 ! X =   207.150,   -187.693,    1160.5,    0 ! !END! gaar-0078
00225 ! X =   -49.973,   -233.657,     828.0,    0 ! !END! gaar-0079
00226 ! X =    69.969,   -178.040,    1022.6,    0 ! !END! gaar-0080
00227 ! X =    79.963,   -186.130,     910.7,    0 ! !END! gaar-0081
00228 ! X =    89.958,   -191.773,    1380.7,    0 ! !END! gaar-0082
00229 ! X =    99.953,   -191.525,    1140.1,    0 ! !END! gaar-0083
00230 ! X =   109.947,   -198.040,    1315.0,    0 ! !END! gaar-0084
00231 ! X =   119.942,   -198.714,    1370.2,    0 ! !END! gaar-0085
00232 ! X =   129.937,   -199.063,    1196.1,    0 ! !END! gaar-0086
00233 ! X =   139.932,   -199.308,     734.7,    0 ! !END! gaar-0087
00234 ! X =   149.928,   -198.740,    1182.6,    0 ! !END! gaar-0088
00235 ! X =   159.923,   -198.134,    1469.7,    0 ! !END! gaar-0089
00236 ! X =   169.920,   -193.979,    1492.8,    0 ! !END! gaar-0090
00237 ! X =   179.915,   -191.962,    1491.0,    0 ! !END! gaar-0091
00238 ! X =   189.911,   -191.236,    1450.4,    0 ! !END! gaar-0092
00239 ! X =   199.908,   -185.627,    1439.5,    0 ! !END! gaar-0093
00240 ! X =   209.906,   -178.674,    1193.4,    0 ! !END! gaar-0094
00241 ! X =   209.906,   -180.460,    1169.8,    0 ! !END! gaar-0095
00242 ! X =   -25.853,   -217.641,     937.0,    0 ! !END! gaar-0096
00243 ! X =   -25.724,   -207.647,    1021.2,    0 ! !END! gaar-0097
00244 ! X =   -25.597,   -197.651,    1148.8,    0 ! !END! gaar-0098
00245 ! X =   -25.468,   -187.656,     972.5,    0 ! !END! gaar-0099
00246 ! X =    55.656,   -177.663,     904.5,    0 ! !END! gaar-0100
00247 ! X =   -59.968,   -224.883,     894.3,    0 ! !END! gaar-0101
00248 ! X =    89.960,   -177.032,     856.3,    0 ! !END! gaar-0102
00249 ! X =    99.955,   -181.487,     973.3,    0 ! !END! gaar-0103
00250 ! X =   109.951,   -176.243,     753.8,    0 ! !END! gaar-0104
00251 ! X =   119.944,   -188.674,    1107.6,    0 ! !END! gaar-0105
00252 ! X =   129.940,   -188.183,     985.4,    0 ! !END! gaar-0106
00253 ! X =   139.935,   -189.263,     855.9,    0 ! !END! gaar-0107
00254 ! X =   149.930,   -188.694,    1012.9,    0 ! !END! gaar-0108
00255 ! X =   159.926,   -188.084,    1253.6,    0 ! !END! gaar-0109
00256 ! X =   169.924,   -177.759,    1161.5,    0 ! !END! gaar-0110
00257 ! X =   189.916,   -176.336,    1501.1,    0 ! !END! gaar-0111
00258 ! X =   189.915,   -178.640,    1591.6,    0 ! !END! gaar-0112
00259 ! X =   189.914,   -181.177,    1642.1,    0 ! !END! gaar-0113
00260 ! X =   199.915,   -165.879,    1059.7,    0 ! !END! gaar-0114
00261 ! X =   199.914,   -169.667,    1170.0,    0 ! !END! gaar-0115
00262 ! X =   199.912,   -175.566,    1341.7,    0 ! !END! gaar-0116
00263 ! X =   209.911,   -165.065,     809.0,    0 ! !END! gaar-0117
00264 ! X =   219.908,   -164.211,    1159.3,    0 ! !END! gaar-0118
00265 ! X =   219.907,   -166.298,    1202.6,    0 ! !END! gaar-0119
00266 ! X =   219.899,   -185.141,    1556.5,    0 ! !END! gaar-0120
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00267 ! X =    79.969,   -148.394,      468.9,    0 ! !END! gaar-0121
00268 ! X =    95.662,   -160.383,      650.4,    0 ! !END! gaar-0122
00269 ! X =   150.448,     29.665,       10.0,    0 ! !END! nuiq-0001
--------------
```

[a] Data for each receptor are treated as a separate input subgroup and therefore must end with an input group terminator.

[b] Receptor height above ground is optional. If no value is entered, the receptor is placed on the ground.

2. Sample CALPOST Input File

```
Class I Analysis 2009 Visibility Analysis
anwr Recs
Visibility Method 8 Mode 5 (FLAG 2008) using calpost v6.221
---------------- Run title (3 lines) ------------------------------------------
-----

                    CALPOST MODEL CONTROL FILE
                    --------------------------

--------------------------------------------------------------------------------
-----

INPUT GROUP: 0 -- Input and Output File Names
--------------

Input Files
-----------

File                        Default File Name
----                        -----------------
Conc/Dep Flux File          MODEL.DAT            ! MODDAT =../gmt2.2009.con !
Relative Humidity File      VISB.DAT             * VISDAT =     *
Background Data File        BACK.DAT             * BACKDAT =    *
Transmissometer or          VSRN.DAT             * VSRDAT =     *
Nephelometer Data File       or
DATSAV Weather Data File     or
Prognostic Weather  File

Single-point Met File       SURFACE.DAT          * MET1DAT =    *
 (Used ONLY to identify CALM hours for plume model
  output averaging when MCALMPRO option is used)


Output Files
------------

File                        Default File Name
----                        -----------------
List File                   CALPOST.LST          ! PSTLST
=vis.anwr.2009.mth8.lst !

Pathname for Timeseries Files   (blank)          * TSPATH =    *
(activate with exclamation points only if
providing NON-BLANK character string)

Pathname for Plot Files   (blank)                * PLPATH =    *
(activate with exclamation points only if
 providing NON-BLANK character string)
```

```
User Character String (U) to augment default filenames
(activate with exclamation points only if
 providing NON-BLANK character string)

Timeseries              TSERIES_ASPEC_ttHR_CONC_TSUNAM.DAT
Peak Value              PEAKVAL_ASPEC_ttHR_CONC_TSUNAM.DAT
                                                   * TSUNAM =     *


Top Nth Rank Plot       RANK(ALL)_ASPEC_ttHR_CONC_TUNAM.DAT
                    or  RANK(ii)_ASPEC_ttHR_CONC_TUNAM.GRD
                                                   ! TUNAM = anwr09m8   !


Exceedance Plot          EXCEED_ASPEC_ttHR_CONC_XUNAM.DAT
                     or  EXCEED_ASPEC_ttHR_CONC_XUNAM.GRD
                                                   * XUNAM =     *


Echo Plot
(Specific Days)
        yyyy_Mmm_Ddd_hhmm(UTCszzzz)_L00_ASPEC_ttHR_CONC.DAT
    or  yyyy_Mmm_Ddd_hhmm(UTCszzzz)_L00_ASPEC_ttHR_CONC.GRD


Visibility Plot         DAILY_VISIB_VUNAM.DAT    ! VUNAM = anwr09m8   !
(Daily Peak Summary)


Auxiliary Output Files
----------------------

File                        Default File Name
----                        -----------------
Visibility Change           DELVIS.DAT          ! DVISDAT
=delv_anwr.2009.mth8.dat !

----------------------------------------------------------------------------
------
All file names will be converted to lower case if LCFILES = T
Otherwise, if LCFILES = F, file names will be converted to UPPER CASE
        T = lower case                      ! LCFILES = T !
        F = UPPER CASE
NOTE: (1) file/path names can be up to 132 characters in length
NOTE: (2) Filenames for ALL PLOT and TIMESERIES FILES are constructed
          using a template that includes a pathname, user-supplied
          character(s), and context-specific strings, where
             ASPEC = Species Name
              CONC = CONC Or WFLX Or DFLX Or TFLX
                tt = Averaging Period (e.g. 03)
                ii = Rank (e.g. 02)
                hh = Hour(ending) in LST
             szzzz = LST time zone shift (EST is -0500)
              yyyy = Year(LST)
```

```
          mm = Month(LST)
          dd = day of month (LST)
       are determined internally based on selections made below.
       If a path or user-supplied character(s) are supplied, each
       must contain at least 1 non-blank character.

!END!
--------------------------------------------------------------------------------
------

INPUT GROUP: 1 -- General run control parameters
--------------

    Option to run all periods found
    in the met. file(s)  (METRUN)     Default: 0     ! METRUN =   0  !

       METRUN = 0 - Run period explicitly defined below
       METRUN = 1 - Run all periods in CALPUFF data file(s)

    Starting date:    Year   (ISYR)  --    No default    ! ISYR  =  2009
!
                      Month  (ISMO)  --    No default    ! ISMO  =  1   !
                      Day    (ISDY)  --    No default    ! ISDY  =  1   !
    Starting time:    Hour   (ISHR)  --    No default    ! ISHR  =  0   !
                      Minute (ISMIN) --    No default    ! ISMIN =  0   !
                      Second (ISSEC) --    No default    ! ISSEC =  0   !

    Ending date:      Year   (IEYR)  --    No default    ! IEYR  =  2009
!
                      Month  (IEMO)  --    No default    ! IEMO  =  12  !
                      Day    (IEDY)  --    No default    ! IEDY  =  31  !
    Ending time:      Hour   (IEHR)  --    No default    ! IEHR  =  24  !
                      Minute (IEMIN) --    No default    ! IEMIN =  0   !
                      Second (IESEC) --    No default    ! IESEC =  0   !

     (These are only used if METRUN = 0)

    All times are in the base time zone of the CALPUFF simulation.
    CALPUFF Dataset Version 2.1 contains the zone, but earlier versions
    do not, and the zone must be specified here.  The zone is the
    number of hours that must be ADDED to the time to obtain UTC (or
GMT).
    Identify the Base Time Zone for the CALPUFF simulation
                              (BTZONE) -- No default    ! BTZONE = 9.0 !

    Process every period of data?
                                (NREP) -- Default: 1    ! NREP   =  1   !
      (1 = every period processed,
       2 = every 2nd period processed,
       5 = every 5th period processed, etc.)

Species & Concentration/Deposition Information
-----------------------------------------------
```

```
Species to process (ASPEC)        -- No default     ! ASPEC = VISIB  !
(ASPEC = VISIB for visibility processing)

Layer/deposition code (ILAYER)    -- Default: 1     ! ILAYER =  1  !
  '1'  for CALPUFF concentrations,
  '-1' for dry deposition fluxes,
  '-2' for wet deposition fluxes,
  '-3' for wet+dry deposition fluxes.

Scaling factors of the form:      -- Defaults:      ! A =   0.0    !
     X(new) = X(old) * A + B         A = 0.0        ! B =   0.0    !
  (NOT applied if A = B = 0.0)       B = 0.0

Add Hourly Background Concentrations/Fluxes?
                          (LBACK)  -- Default: F    ! LBACK =  F !


Source of NO2 when ASPEC=NO2 (above) or LVNO2=T (Group 2) may be
from CALPUFF NO2 concentrations OR from a fraction of CALPUFF NOx
concentrations.  Specify the fraction of NOx that is treated as NO2
either as a constant or as a table of fractions that depend on the
magnitude of the NOx concentration:
                         (NO2CALC) -- Default: 1    ! NO2CALC =   1  !
    0 =  Use NO2 directly (NO2 must be in file)
    1 =  Specify a single NO2/NOx ratio (RNO2NOX)
    2 =  Specify a table NO2/NOx ratios (TNO2NOX)
         (NOTE: Scaling Factors must NOT be used with NO2CALC=2)

Single NO2/NOx ratio (0.0 to 1.0) for treating some
or all NOx as NO2, where [NO2] = [NOX] * RNO2NOX
(used only if NO2CALC = 1)
                         (RNO2NOX) -- Default: 1.0 ! RNO2NOX = 1.0 !

Table of NO2/NOx ratios that vary with NOx concentration.
Provide 14 NOx concentrations (ug/m**3) and the corresponding
NO2/NOx ratio, with NOx increasing in magnitude.  The ratio used
for a particular NOx concentration is interpolated from the values
provided in the table.  The ratio for the smallest tabulated NOx
concentration (the first) is used for all NOx concentrations less
than the smallest tabulated value, and the ratio for the largest
tabulated NOx concentration (the last) is used for all NOx
concentrations greater than the largest tabulated value.
(used only if NO2CALC = 2)

 NOx concentration(ug / m3)
                          (CNOX)    -- No default
   ! CNOX = 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0,
            8.0, 9.0, 10.0, 11.0, 12.0, 13.0, 14.0 !

 NO2/NOx ratio for each NOx concentration:
                          (TNO2NOX) -- No default
   ! TNO2NOX = 1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0,
               1.0, 1.0, 1.0, 1.0, 1.0, 1.0, 1.0 !
```

```
Source information
------------------

  Option to process source contributions:
        0 =  Process only total reported contributions
        1 =  Sum all individual source contributions and process
        2 =  Run in TRACEBACK mode to identify source
             contributions at a SINGLE receptor
                        (MSOURCE) -- Default: 0   ! MSOURCE =  0  !


Plume Model Output Processing Options
-------------------------------------

  Output from models other than CALPUFF and CALGRID can be written in
  the CONC.DAT format and processed by CALPOST.  Plume models such as
  AERMOD typically do not treat CALM hours, and do not include such hours
  in multiple-hour averages, with specific rules about how many calm hours
  can be removed from an average.  This treatment is known as CALM
  PROCESSING.  Calm periods are identified from wind speeds in the
  meteorological data file for the application, which must be identified
  in Input Group 0 as the single-point meteorological data file MET1DAT.
        0 =  Option is not used for CALPUFF/CALGRID output files
        1 =  Apply CALM processing procedures to multiple-hour averages
                     (MCALMPRO) -- Default: 0    ! MCALMPRO =  0  !

  Format of Single-point Met File
        1 =  AERMOD/AERMET SURFACE file
                       (MET1FMT) -- Default: 1    ! MET1FMT =  1  !


Receptor information
--------------------

  Gridded receptors processed?    (LG) -- Default: F    ! LG   = F  !
  Discrete receptors processed?   (LD) -- Default: F    ! LD   = T  !
  CTSG Complex terrain receptors processed?
                                 (LCT) -- Default: F    ! LCT  = F  !

--Report results by DISCRETE receptor RING?
  (only used when LD = T)    (LDRING) -- Default: F    ! LDRING = F  !

--Select range of DISCRETE receptors (only used when LD = T):

  Select ALL DISCRETE receptors by setting NDRECP flag to -1;
                                  OR
  Select SPECIFIC DISCRETE receptors by entering a flag (0,1) for each
     0 = discrete receptor not processed
     1 = discrete receptor processed
  using repeated value notation to select blocks of receptors:
     23*1, 15*0, 12*1
  Flag for all receptors after the last one assigned is set to 0
  (NDRECP) -- Default: -1
```

```
                                        anwr      ! NDRECP =  146*1, 122*0
!


--Select range of GRIDDED receptors (only used when LG = T):

      X index of LL corner (IBGRID) -- Default: -1       ! IBGRID = -1   !
          (-1 OR 1 <= IBGRID <= NX)

      Y index of LL corner (JBGRID) -- Default: -1       ! JBGRID = -1   !
          (-1 OR 1 <= JBGRID <= NY)

      X index of UR corner (IEGRID) -- Default: -1       ! IEGRID = -1   !
          (-1 OR 1 <= IEGRID <= NX)

      Y index of UR corner (JEGRID) -- Default: -1       ! JEGRID = -1   !
          (-1 OR 1 <= JEGRID <= NY)

  Note: Entire grid is processed if IBGRID=JBGRID=IEGRID=JEGRID=-1


--Specific gridded receptors can also be excluded from CALPOST
  processing by filling a processing grid array with 0s and 1s.  If the
  processing flag for receptor index (i,j) is 1 (ON), that receptor
  will be processed if it lies within the range delineated by IBGRID,
  JBGRID,IEGRID,JEGRID and if LG=T. If it is 0 (OFF), it will not be
  processed in the run.  By default, all array values are set to 1 (ON).

  Number of gridded receptor rows provided in Subgroup (1a) to
  identify specific gridded receptors to process
                            (NGONOFF) -- Default: 0      ! NGONOFF =  0   !

!END!


--------------
Subgroup (1a) -- Specific gridded receptors included/excluded
--------------

    Specific gridded receptors are excluded from CALPOST processing
    by filling a processing grid array with 0s and 1s.  A total of
    NGONOFF lines are read here.  Each line corresponds to one 'row'
    in the sampling grid, starting with the NORTHERNMOST row that
    contains receptors that you wish to exclude, and finishing with
    row 1 to the SOUTH (no intervening rows may be skipped).  Within
    a row, each receptor position is assigned either a 0 or 1,
    starting with the westernmost receptor.
       0 = gridded receptor not processed
       1 = gridded receptor processed

    Repeated value notation may be used to select blocks of receptors:
       23*1, 15*0, 12*1
```

```
Because all values are initially set to 1, any receptors north of
the first row entered, or east of the last value provided in a row,
remain ON.

(NGXRECP) -- Default: 1

-------------------------------------------------------------------------------
-----

INPUT GROUP: 2 -- Visibility Parameters (ASPEC = VISIB)
---------------

    Test visibility options specified to see
    if they conform to FLAG 2008 configuration?
                          (MVISCHECK) -- Default: 1    ! MVISCHECK =   1

!
       0 =  NO checks are made
       1 =  Technical options must conform to FLAG 2008 visibility
guidance
              ASPEC = VISIB
              LVNO2 = T
              NO2CALC = 1
              RNO2NOX = 1.0
              MVISBK = 8
              M8_MODE = 5

    Some of the data entered for use with the FLAG 2008 configuration
    are specific to the Class I area being evaluated. These values can
    be checked within the CALPOST user interface when the name of the
    Class I area is provided.

    Name of Class I Area (used for QA purposes only)
                        (AREANAME) -- Default: User   ! AREANAME = anwr

!

    Particle growth curve f(RH) for hygroscopic species
                           (MFRH) -- Default: 4    ! MFRH    =  4  !


         1 =  IWAQM (1998) f(RH) curve (originally used with MVISBK=1)
         2 =  FLAG (2000) f(RH) tabulation
         3 =  EPA (2003) f(RH) tabulation
         4 =  IMPROVE (2006) f(RH) tabulations for sea salt, and for small
and
              large SULFATE and NITRATE particles;
              Used in Visibility Method 8 (MVISBK = 8 with M8_MODE = 1, 2,
or 3)

    Maximum relative humidity (%) used in particle growth curve
                          (RHMAX) -- Default: 98   ! RHMAX   = 95.0 !

    Modeled species to be included in computing the light extinction
     Include SULFATE?            (LVSO4) -- Default: T    ! LVSO4   = T   !
     Include NITRATE?            (LVNO3) -- Default: T    ! LVNO3   = T   !
```

```
Include ORGANIC CARBON?   (LVOC)  -- Default: T   ! LVOC    = T   !
Include COARSE PARTICLES? (LVPMC) -- Default: T   ! LVPMC   = T   !
Include FINE PARTICLES?   (LVPMF) -- Default: T   ! LVPMF   = T   !
Include ELEMENTAL CARBON? (LVEC)  -- Default: T   ! LVEC    = T   !
Include NO2 absorption?   (LVNO2) -- Default: F   ! LVNO2   = T   !
     With Visibility Method 8 -- Default: T
                                  FLAG (2008)

And, when ranking for TOP-N, TOP-50, and Exceedance tables,
 Include BACKGROUND?          (LVBK)  -- Default: T   ! LVBK    = F   !

Species name used for particulates in MODEL.DAT file
              COARSE     (SPECPMC) -- Default: PMC ! SPECPMC = PMC !
              FINE       (SPECPMF) -- Default: PMF ! SPECPMF = PMF !

Extinction Efficiency (1/Mm per ug/m**3)
----------------------------------------
  MODELED particulate species:
           PM  COARSE        (EEPMC) -- Default: 0.6    ! EEPMC   = 0.6 !
           PM  FINE          (EEPMF) -- Default: 1.0    ! EEPMF   = 1 !
  BACKGROUND particulate species:
           PM  COARSE      (EEPMCBK) -- Default: 0.6    ! EEPMCBK = 0.6 !
  Other species:
           AMMONIUM SULFATE (EESO4) -- Default: 3.0    ! EESO4   = 3 !
           AMMONIUM NITRATE (EENO3) -- Default: 3.0    ! EENO3   = 3 !
           ORGANIC CARBON   (EEOC)  -- Default: 4.0    ! EEOC    = 4 !
           SOIL             (EESOIL)-- Default: 1.0    ! EESOIL  = 1 !
           ELEMENTAL CARBON (EEEC)  -- Default: 10.    ! EEEC    = 10 !
           NO2 GAS          (EENO2) -- Default: .1755  ! EENO2   = 0.1755
!
  Visibility Method 8:
           AMMONIUM SULFATE (EESO4S)   Set Internally (small)
           AMMONIUM SULFATE (EESO4L)   Set Internally (large)
           AMMONIUM NITRATE (EENO3S)   Set Internally (small)
           AMMONIUM NITRATE (EENO3L)   Set Internally (large)
           ORGANIC CARBON   (EEOCS)    Set Internally (small)
           ORGANIC CARBON   (EEOCL)    Set Internally (large)
           SEA SALT         (EESALT)   Set Internally

Background Extinction Computation
---------------------------------

  Method used for the 24h-average of percent change of light extinction:
  Hourly ratio of source light extinction / background light extinction
  is averaged?              (LAVER) -- Default: F   ! LAVER = F   !

  Method used for background light extinction
                          (MVISBK) -- Default: 8    ! MVISBK =  8   !
                                      FLAG (2008)

      1 =  Supply single light extinction and hygroscopic fraction
           - Hourly F(RH) adjustment applied to hygroscopic background
             and modeled sulfate and nitrate
```

```
       2 =  Background extinction from speciated PM concentrations (A)
            - Hourly F(RH) adjustment applied to observed and modeled
sulfate
              and nitrate
            - F(RH) factor is capped at F(RHMAX)
       3 =  Background extinction from speciated PM concentrations (B)
            - Hourly F(RH) adjustment applied to observed and modeled
sulfate
              and nitrate
            - Receptor-hour excluded if RH>RHMAX
            - Receptor-day excluded if fewer than 6 valid receptor-hours
       4 =  Read hourly transmissometer background extinction
measurements
            - Hourly F(RH) adjustment applied to modeled sulfate and
nitrate
            - Hour excluded if measurement invalid (missing,
interference,
              or large RH)
            - Receptor-hour excluded if RH>RHMAX
            - Receptor-day excluded if fewer than 6 valid receptor-hours
       5 =  Read hourly nephelometer background extinction measurements
            - Rayleigh extinction value (BEXTRAY) added to measurement
            - Hourly F(RH) adjustment applied to modeled sulfate and
nitrate
            - Hour excluded if measurement invalid (missing,
interference,
              or large RH)
            - Receptor-hour excluded if RH>RHMAX
            - Receptor-day excluded if fewer than 6 valid receptor-hours
       6 =  Background extinction from speciated PM concentrations
            - FLAG (2000) monthly RH adjustment factor applied to
observed and
              and modeled sulfate and nitrate
       7 =  Use observed weather or prognostic weather information for
            background extinction during weather events; otherwise, use
Method 2
            - Hourly F(RH) adjustment applied to modeled sulfate and
nitrate
            - F(RH) factor is capped at F(RHMAX)
            - During observed weather events, compute Bext from visual
range
              if using an observed weather data file, or
            - During prognostic weather events, use Bext from the
prognostic
              weather file
            - Use Method 2 for hours without a weather event
       8 =  Background extinction from speciated PM concentrations using
            the IMPROVE (2006) variable extinction efficiency
formulation
            (MFRH must be set to 4)
            - Split between small and large particle concentrations of
              SULFATES, NITRATES, and ORGANICS is a function of
concentration
              and different extinction efficiencies are used for each
```

```
          - Source-induced change in visibility includes the increase
in
            extinction of the background aerosol due to the change in
the
            extinction efficiency that now depends on total
concentration.
          - Fsmall(RH) and Flarge(RH) adjustments for small and large
            particles are applied to observed and modeled sulfate and
            nitrate concentrations
          - Fsalt(RH) adjustment for sea salt is applied to background
            sea salt concentrations
          - F(RH) factors are capped at F(RHMAX)
          - RH for Fsmall(RH), Flarge(RH), and Fsalt(RH) may be
obtained
            from hourly data as in Method 2 or from the FLAG monthly
RH
            adjustment factor used for Method 6 where EPA F(RH)
tabulation
            is used to infer RH, or monthly Fsmall, Flarge, and Fsalt
RH
            adjustment factors can be directly entered.
            Furthermore, a monthly RH factor may be applied to either
hourly
            concentrations or daily concentrations to obtain the 24-
hour
            extinction.
            These choices are made using the M8_MODE selection.

   Additional inputs used for MVISBK = 1:
   --------------------------------------
     Background light extinction (1/Mm)
                          (BEXTBK) -- No default    ! BEXTBK = 0.0 !
     Percentage of particles affected by relative humidity
                          (RHFRAC) -- No default    ! RHFRAC = 0.0 !

   Additional inputs used for MVISBK = 6,8:
   ----------------------------------------
     Extinction coefficients for hygroscopic species (modeled and
     background) are computed using a monthly RH adjustment factor
     in place of an hourly RH factor (VISB.DAT file is NOT needed).
     Enter the 12 monthly factors here (RHFAC).  Month 1 is January.

     (RHFAC)  -- No default

     (RHFAC)  -- No default      ! RHFAC = 0, 0, 0, 0,
                                           0, 0, 0, 0,
                                           0, 0, 0, 0 !

   Additional inputs used for MVISBK = 7:
   --------------------------------------
     The weather data file (DATSAV abbreviated space-delimited) that
     is identified as VSRN.DAT may contain data for more than one
     station.  Identify the stations that are needed in the order in
     which they will be used to obtain valid weather and visual range.
```

The first station that contains valid data for an hour will be used. Enter up to MXWSTA (set in PARAMS file) integer station IDs of up to 6 digits each as variable IDWSTA, and enter the corresponding time zone for each, as variable TZONE (= UTC-LST).

A prognostic weather data file with Bext for weather events may be used in place of the observed weather file. Identify this as the VSRN.DAT file and use a station ID of IDWSTA = 999999, and TZONE = 0.

NOTE: TZONE identifies the time zone used in the dataset. The DATSAV abbreviated space-delimited data usually are prepared with UTC time rather than local time, so TZONE is typically set to zero.

```
 (IDWSTA)    -- No default
! IDWSTA = 999999 !
 (TZONE)     -- No default
! TZONE  = 0.0 !
```

Additional inputs used for MVISBK = 2,3,6,7,8:

Background extinction coefficients are computed from monthly CONCENTRATIONS of ammonium sulfate (BKSO4), ammonium nitrate (BKNO3), coarse particulates (BKPMC), organic carbon (BKOC), soil (BKSOIL), and elemental carbon (BKEC). Month 1 is January. (ug/m**3)

```
(BKSO4)  -- No default        ! BKSO4 = 12*0.12 !
(BKNO3)  -- No default        ! BKNO3 = 12*0.05 !
(BKPMC)  -- No default        ! BKPMC = 12*1.12 !
(BKOC)   -- No default        ! BKOC  = 12*0.6  !
(BKSOIL) -- No default        ! BKSOIL= 12*0.14!
(BKEC)   -- No default        ! BKEC  = 12*0.02  !
```

Additional inputs used for MVISBK = 8:

Extinction coefficients for hygroscopic species (modeled and background) may be computed using hourly RH values and hourly modeled concentrations, or using monthly RH values inferred from the RHFAC adjustment factors and either hourly or daily modeled concentrations, or using monthly RHFSML, RHFLRG, and RHFSEA adjustment factors and either hourly or daily modeled concentrations.

```
(M8_MODE) -- Default: 5     ! M8_MODE=  5   !
             FLAG (2008)
```

1 = Use hourly RH values from VISB.DAT file with hourly modeled and monthly background concentrations.

2 = Use monthly RH from monthly RHFAC and EPA (2003) f(RH) tabulation

```
        with hourly modeled and monthly background concentrations.
        (VISB.DAT file is NOT needed).
    3 = Use monthly RH from monthly RHFAC with EPA (2003) f(RH)
tabulation
        with daily modeled and monthly background concentrations.
        (VISB.DAT file is NOT needed).
    4 = Use monthly RHFSML, RHFLRG, and RHFSEA with hourly modeled
        and monthly background concentrations.
        (VISB.DAT file is NOT needed).
    5 = Use monthly RHFSML, RHFLRG, and RHFSEA with daily modeled
        and monthly background concentrations.
        (VISB.DAT file is NOT needed).

  Background extinction coefficients are computed from monthly
  CONCENTRATIONS of sea salt (BKSALT).  Month 1 is January.
  (ug/m**3)

  (BKSALT) -- No default      ! BKSALT= 12*0.04 !

  Extinction coefficients for hygroscopic species (modeled and
  background) can be computed using monthly RH adjustment factors
  in place of an hourly RH factor (VISB.DAT file is NOT needed).
  Enter the 12 monthly factors here (RHFSML,RHFLRG,RHFSEA).
  Month 1 is January.  (Used if M8_MODE = 4 or 5)

  Small ammonium sulfate and ammonium nitrate particle sizes
  (RHFSML) -- No default
! RHFSML= 3.21,3.19,2.71,2.39,2.46,2.69,3.27,4.05,4.17,3.9,3.59,3.58 !

  Large ammonium sulfate and ammonium nitrate particle sizes
  (RHFLRG) -- No default
! RHFLRG= 2.48,2.44,2.15,1.96,1.98,2.13,2.47,2.9,2.95,2.84,2.69,2.68 !

  Sea salt particles
  (RHFSEA) -- No default
! RHFSEA= 3.68,3.57,3.07,2.74,2.74,3.01,3.53,4.13,4.19,4.09,3.92,3.94 !

  Additional inputs used for MVISBK = 2,3,5,6,7,8:
  -----------------------------------------------
  Extinction due to Rayleigh scattering is added (1/Mm)
                      (BEXTRAY) -- Default: 10.0 ! BEXTRAY = 11 !

!END!
---------------------------------------------------------------------------
-----

INPUT GROUP: 3 -- Output options
--------------

Documentation
-------------

  Documentation records contained in the header of the
  CALPUFF output file may be written to the list file.
```

```
   Print documentation image?
                                   (LDOC) -- Default: F   !  LDOC = F !

Output Units
------------
   Units for All Output          (IPRTU) -- Default: 1   ! IPRTU =  3  !
               for                   for
          Concentration          Deposition
      1 =        g/m**3            g/m**2/s
      2 =       mg/m**3           mg/m**2/s
      3 =       ug/m**3           ug/m**2/s
      4 =       ng/m**3           ng/m**2/s
      5 =   Odour Units

   Visibility: extinction expressed in 1/Mega-meters (IPRTU is ignored)


Averaging time(s) reported
--------------------------

   1-pd averages             (L1PD) -- Default: T   !   L1PD = F  !
   (pd = averaging period of model output)

   1-hr averages             (L1HR) -- Default: T   !   L1HR = F  !

   3-hr averages             (L3HR) -- Default: T   !   L3HR = F  !

   24-hr averages           (L24HR) -- Default: T   !  L24HR = T  !

   Run-length averages      (LRUNL) -- Default: T   !  LRUNL = F  !

   User-specified averaging time in hours, minutes, seconds
   - results for this averaging time are reported if it is not zero

                            (NAVGH) -- Default: 0   !  NAVGH =  0  !
                            (NAVGM) -- Default: 0   !  NAVGM =  0  !
                            (NAVGS) -- Default: 0   !  NAVGS =  0  !


Types of tabulations reported
------------------------------

   1) Visibility: daily visibility tabulations are always reported
                  for the selected receptors when ASPEC = VISIB.
                  In addition, any of the other tabulations listed
                  below may be chosen to characterize the light
                  extinction coefficients.
                  [List file or Plot/Analysis File]


   2) Top 50 table for each averaging time selected
      [List file only]
                             (LT50) -- Default: T   !   LT50 = T  !
```

```
3) Top 'N' table for each averaging time selected
   [List file or Plot file]
                              (LTOPN) -- Default: F    ! LTOPN = T  !

   -- Number of 'Top-N' values at each receptor
      selected (NTOP must be <= 4)
                               (NTOP) -- Default: 4    ! NTOP =   4    !

   -- Specific ranks of 'Top-N' values reported
      (NTOP values must be entered)
                      (ITOP(4) array) -- Default:      ! ITOP =  1 , 2 , 3 , 4
!
                                         1,2,3,4


4) Threshold exceedance counts for each receptor and each averaging
   time selected
   [List file or Plot file]
                              (LEXCD) -- Default: F    !  LEXCD = F  !

   -- Identify the threshold for each averaging time by assigning a
      non-negative value (output units).

                                      -- Default: -1.0
      Threshold for  1-hr averages    (THRESH1) !  THRESH1 = -1.0   !
      Threshold for  3-hr averages    (THRESH3) !  THRESH3 = -1.0   !
      Threshold for 24-hr averages   (THRESH24) ! THRESH24 = -1.0   !
      Threshold for NAVG-hr averages (THRESHN) !  THRESHN = -1.0   !


   -- Counts for the shortest averaging period selected can be
      tallied daily, and receptors that experience more than NCOUNT
      counts over any NDAY period will be reported.  This type of
      exceedance violation output is triggered only if NDAY > 0.

      Accumulation period(Days)
                               (NDAY) -- Default: 0    !    NDAY =  0   !
      Number of exceedances allowed
                             (NCOUNT) -- Default: 1    !  NCOUNT =  1   !


5) Selected day table(s)

   Echo Option -- Many records are written each averaging period
   selected and output is grouped by day
   [List file or Plot file]
                              (LECHO) -- Default: F    !  LECHO = F  !

   Timeseries Option -- Averages at all selected receptors for
   each selected averaging period are written to timeseries files.
   Each file contains one averaging period, and all receptors are
   written to a single record each averaging time.
   [TSERIES_ASPEC_ttHR_CONC_TSUNAM.DAT files]
                              (LTIME) -- Default: F    !  LTIME = F  !
```

Peak Value Option -- Averages at all selected receptors for each selected averaging period are screened and the peak value each period is written to timeseries files.
Each file contains one averaging period.
[PEAKVAL_ASPEC_ttHR_CONC_TSUNAM.DAT files]
(LPEAK) -- Default: F ! LPEAK = F !

-- Days selected for output
(IECHO(366)) -- Default: 366*0
! IECHO = 366*0 !
(366 values must be entered)

Plot output options

Plot files can be created for the Top-N, Exceedance, and Echo tables selected above. Two formats for these files are available, DATA and GRID. In the DATA format, results at all receptors are listed along with the receptor location [x,y,val1,val2,...].
In the GRID format, results at only gridded receptors are written, using a compact representation. The gridded values are written in rows (x varies), starting with the most southern row of the grid.
The GRID format is given the .GRD extension, and includes headers compatible with the SURFER(R) plotting software.

A plotting and analysis file can also be created for the daily peak visibility summary output, in DATA format only.

Generate Plot file output in addition to writing tables to List file?
(LPLT) -- Default: F ! LPLT = T !

Use GRID format rather than DATA format, when available?
(LGRD) -- Default: F ! LGRD = F !

Auxiliary Output Files (for subsequent analyses)

Visibility

A separate output file may be requested that contains the change in visibility at each selected receptor when ASPEC = VISIB. This file can be processed to construct visibility measures that are not available in CALPOST.

Output file with the visibility change at each receptor?
(MDVIS) -- Default: 0 ! MDVIS = 2 !

0 = Do Not create file
1 = Create file of DAILY (24 hour) Delta-Deciview
2 = Create file of DAILY (24 hour) Extinction Change (%)

```
        3 =  Create file of HOURLY Delta-Deciview
        4 =  Create file of HOURLY Extinction Change (%)


Additional Debug Output
-----------------------

   Output selected information to List file
    for debugging?
                                   (LDEBUG) -- Default: F  ! LDEBUG  = F !

   Output hourly extinction information to REPORT.HRV?
    (Visibility Method 7)
                                  (LVEXTHR) -- Default: F  ! LVEXTHR = F !

!END!
```

3. Sample POSTUTIL Input File

```
Greater Mooses Tooth 2, Alt A total deposition fluxes (wet & dry), 2009
Simulation
N due to NOx, HNO3, NH4NO3, and (NH4)2SO4
S due to SO2, (NH4)2SO4
---------------- Run title (3 lines) ------------------------------------------
-----

                    POSTUTIL MODEL CONTROL FILE
                    ---------------------------

-------------------------------------------------------------------------------
-----

INPUT GROUP: 0 -- Input and Output File Names
--------------

-------------
Subgroup (0a)
-------------

Output Files
------------

 File             Default File Name
 ----             -----------------
 List File        POSTUTIL.LST         ! UTLLST =tdep.2009.lst    !
 Data File        MODEL.DAT            ! UTLDAT =tdep.2009.dep    !


Input Files
-----------

 A time-varying file of "background" concentrations can be included
 when the ammonia-limiting method (ALM) for setting the HNO3/NO3
 concentration partition is accomplished in 1 step.  This option
 is selected by setting MNITRATE=3 in Input Group 1.
 Species required in the "background" concentration file are:
 SO4, NO3, HNO3 and TNH3 (total NH3 = NH3gaseous + NH3particulate).

 File             Default File Name
 ----             -----------------
 BCKG File        BCKGALM.DAT          * BCKGALM =BCKGALM.DAT     *


 A number of CALPUFF data files may be processed in this application.
 The files may represent individual CALPUFF simulations that were made
 for a specific set of species and/or sources.  Specify the total number
 of CALPUFF runs you wish to combine, and provide the filename for each
```

```
in subgroup 0b.

    Number of CALPUFF data files (NFILES)
                                        Default: 1        ! NFILES   = 2    !


 Meteorological data files are needed for the HNO3/NO3 partition option.
 Three types of meteorological data files can be used:
       METFM= 0 - CALMET.DAT
       METFM= 1 - 1-D file with RH, Temp and Rhoair timeseries
       METFM= 2 - 2-D files with either Rh, Temp or Rhoair in each
                  (3 2_D files are needed)
     The default is to use CALMET.DAT files.

                                        Default: 0        ! METFM    = 0    !


 Multiple meteorological data files may be used in sequence to span the
 processing period.  Specify the number of time-period files (NMET) that
 you need to use, and provide a filename for each in subgroup 0b.
 - NMET is 0 if no meteorological files are provided
 - NMET is 1 if METFM=1 (multiple file feature is not available)
 - NMET is 1 or more if METFM=0 or 2 (multiple CALMET files or 2DMET
files)

    Number of meteorological data file time-periods (NMET)
                                        Default: 0        ! NMET     = 0    !


 All filenames will be converted to lower case if LCFILES = T
 Otherwise, if LCFILES = F, filenames will be converted to UPPER CASE

    Convert filenames to lower case?  Default: T      ! LCFILES = T !
        T = lower case
        F = UPPER CASE

!END!

-----------------------------------------------------------
 NOTE: file/path names can be up to 70 characters in length
-----------------------------------------------------------

-------------
Subgroup (0b)
-------------

NMET CALMET Data Files (METFM=0):

Input File      Default File Name
----------      -----------------
   1            MET.DAT           * UTLMET =CALMET.DAT  * *END*
```

```
NMET 1-D Data Files (METFM=1):

Input File        Default File Name
----------        -----------------
   1              MET_1D.DAT          * MET1D    = MET_1D.DAT * *END*


NMET 2-D Data Files of Each Type (METFM=2):

Input File        Default File Name
----------        -----------------
   1              RHUMD.DAT           * M2DRHU   = RELHUM.DAT * *END*
   1              TEMP.DAT            * M2DTMP   = TEMP.DAT   * *END*
   1              RHOAIR.DAT          * M2DRHO   = RHOAIR.DAT * *END*


NFILES CALPUFF Data Files:

Input File        Default File Name
----------        -----------------
   1              CALPUFF.DAT         ! MODDAT = gmt2.2009.wet    ! !END!
   2              (none)              ! MODDAT = gmt2.2009.dry    ! !END!


-------------
Note:  provide NMET lines of the form    * UTLMET = name * *END*

                                     or    * MET1D  = name * *END*

                                     or    * M2DRHU = name * *END*
                                  (and)    * M2DTMP = name * *END*
                                  (and)    * M2DRHO = name * *END*

       and NFILES lines of the form        * MODDAT = name * *END*

       where the * should be replaced with an exclamation point,
       the special delimiter character.


------------------------------------------------------------------------------
------

INPUT GROUP: 1 -- General run control parameters
--------------

     Starting date:     Year  (ISYR) --    No default    ! ISYR   =  2009 !
                        Month (ISMO) --    No default    ! ISMO   = 1     !
                        Day   (ISDY) --    No default    ! ISDY   = 1     !
                        Hour  (ISHR) --    No default    ! ISHR   = 1     !

     Number of periods to process
                               (NPER) -- No default      ! NPER   = 8760 !

     Number of species to process from CALPUFF runs
```

```
                    (NSPECINP) -- No default    ! NSPECINP = 5 !

    Number of species to write to output file
                    (NSPECOUT) -- No default    ! NSPECOUT = 2 !

    Number of species to compute from those modeled
    (must be no greater than NSPECOUT)
                    (NSPECCMP) -- No default    ! NSPECCMP = 2 !
```

When multiple files are used, a species name may appear in more than one file. Data for this species will be summed (appropriate if the CALPUFF runs use different source groups). If this summing is not appropriate, remove duplicate species from the file(s).

```
    Stop run if duplicate species names
    are found? (MDUPLCT)            Default: 0      ! MDUPLCT  =  0  !
       0 = no  (i.e., duplicate species are summed)
       1 = yes (i.e., run is halted)
```

Data for each species in a CALPUFF data file may also be scaled as they are read. This can be done to alter the emission rate of all sources that were modeled in a particular CALPUFF application. The scaling factor for each species is entered in Subgroup (2d), for each file for which scaling is requested.

```
    Number of CALPUFF data files that will be scaled
    (must be no greater than NFILES)
    (NSCALED)                       Default: 0      ! NSCALED = 0 !
```

Ammonia-Limiting Method Option to recompute the HNO3/NO3 concentration partition prior to performing other actions is controlled by MNITRATE. This option will NOT alter any deposition fluxes contained in the CALPUFF file(s). Three partition selections are provided. The first two are typically used in sequence (POSTUTIL is run more than once). The first selection (MNITRATE=1) computes the partition for the TOTAL (all sources) concentration fields (SO4, NO3, HNO3; NH3), and the second (MNITRATE=2) uses this partition (from the previous application of POSTUTIL) to compute the partition for individual source groups. The third selection (MNITRATE=3) can be used instead in a single POSTUTIL application if a file of background concentrations is provided (BCKGALM in Input Group 0).

```
Required information for MNITRATE=1 includes:
         species NO3, HNO3, and SO4
         NH3 concentration(s)
         met. data file for RH and T

Required information for MNITRATE=2 includes:
         species NO3 and HNO3 for a source group
         species NO3ALL and HNO3ALL for all source groups, properly
         partitioned

Required information for MNITRATE=3 includes:
```

species NO3, HNO3, and SO4 for a source group
species NO3, HNO3, SO4 and TNH3 from the background BCKGALM file
If TNH3 is not in the background BCKGALM file, monthly TNH3
concentrations are used (BCKTNH3)
TNH3= total NH3 = NH3gaseous+NH3particulate

Recompute the HNO3/NO3 partition for concentrations?
(MNITRATE) Default: 0 ! MNITRATE = 0 !
0 = no
1 = yes, for all sources combined
2 = yes, for a source group
3 = yes, ALM application in one step

SOURCE OF AMMONIA:

Ammonia may be available as a modeled species in the CALPUFF files, and it may or may not be appropriate to use it for repartitioning NO3/HNO3 (in option MNITRATE=1 or MNITRATE=3). Its use is contolled by NH3TYP. When NH3 is listed as a processed species in Subgroup (2a), as one of the NSPECINP ASPECI entries, and the right option is chosen for NH3TYP, the NH3 modeled values from the CALPUFF concentration files will be used in the chemical equilibrium calculation.

NH3TYP also controls when monthly background ammonia values are used. Both gaseous (NH3) and total (TNH3=NH3gaseous+NH3particulate) ammonia can be provided monthly as BCKNH3/BCKTNH3.

What is the input source of Ammonia?
(NH3TYP) No Default ! NH3TYP = 0 !
0 = No background will be used.
ONLY NH3 or TNH3 from the concentration
files listed in Subgroup (2a&2b) as
a processed species will be used.
(Cannot be used with MNITRATE=3)

1 = NH3 Monthly averaged background (BCKNH3)
listed below will be added to NH3 from
concentration files listed in Subgroup (2a)

2 = NH3 from background concentration file BCKGALM
will be added to NH3 from concentration files
listed in Subgroup (2a&2b)
(ONLY possible for MNITRATE=3)

3 = NH3 Monthly averaged background (BCKNH3)
listed below will be used alone.

4 = NH3 from background concentration file BCKGALM
will be used alone
(ONLY possible for MNITRATE=3)

```
 | OPTION | NH3 or TNH3 CONC | BCKNH3 or BCKTNH3 | TNH3/BCKGALM or BCKTNH3
|
 |--------|------------------|-------------------|------------------------
-|
 |   0    |        X         |         0         |             0
|
 |--------|------------------|-------------------|------------------------
-|
 |   1    |        X         |         X         |             0
|
 |--------|------------------|-------------------|------------------------
-|
 |   2    |        X         |         0         |             X
|
 |--------|------------------|-------------------|------------------------
-|
 |   3    |        0         |         X         |             0
|
 |--------|------------------|-------------------|------------------------
-|
 |   4    |        0         |         0         |             X
|
 |--------|------------------|-------------------|------------------------
-|

     Default monthly (12 values) background ammonia concentration (ppb)
     used for HNO3/NO3 partition (need to choose one or the other):

      Gaseous NH3 (BCKNH3)            Default: -999
      * BCKNH3 = 1., 1., 1., 1.1, 1.4, 1.3, 1.3, 1.2, 4*1. *

      Total TNH3  (BCKTNH3)           Default: -999
      * BCKTNH3 = 1., 1., 1., 1.1, 1.4, 1.3, 1.3, 1.2, 4*1. *

     If a single value is entered, this is used for all 12 months.
     Month 1 is JANUARY, Month 12 is DECEMBER.

!END!
--------------------------------------------------------------------------
-----

INPUT GROUP: 2 -- Species Processing Information
--------------

-------------
Subgroup (2a)
-------------

  The following NSPECINP species will be processed:

! ASPECI =          SO2 !           !END!
! ASPECI =          SO4 !           !END!
```

```
! ASPECI =          NOX !          !END!
! ASPECI =         HNO3 !          !END!
! ASPECI =          NO3 !          !END!


-------------
Subgroup (2b)
-------------

  The following NSPECOUT species will be written:

! ASPECO =        TOTN !          !END!
! ASPECO =        TOTS !          !END!

-------------
Subgroup (2c)
-------------

  The following NSPECCMP species will be computed by scaling and summing
  one or more of the processed input species.  Identify the name(s) of
  the computed species and provide the scaling factors for each of the
  NSPECINP input species (NSPECCMP groups of NSPECINP+1 lines each):

! CSPECCMP =     TOTN !
!     SO2  =     0.0      !
!     SO4  =     0.291667 !  28/96
!     NOX  =     0.3043   !  14/46
!    HNO3  =     0.222222 !  14/63
!     NO3  =     0.451613 !  28/62
!END!

! CSPECCMP =     TOTS !
!     SO2  =     0.500000 !  32/64
!     SO4  =     0.333333 !  32/96
!     NOX  =     0.0 !
!    HNO3  =     0.0 !
!     NO3  =     0.0 !
!END!


-------------
Subgroup (2d)
-------------

  Each species in NSCALED CALPUFF data files may be scaled before being
  processed (e.g., to change the emission rate for all sources modeled
  in the run that produced a data file).  For each file, identify the
  file name and then provide the name(s) of the scaled species and the
  corresponding scaling factors (A,B where x' = Ax+B).

                    A(Default=1.0)      B(Default=0.0)
                    --------------      --------------

* MODDAT =NOFILES.DAT    *
```

```
*      SO2  =      1.1,                    0.0    *
*      SO4  =      1.5,                    0.0    *
*     HNO3  =      0.8,                    0.0    *
*      NO3  =      0.1,                    0.0    *
*END*
```

[illegible]

[illegible]

The following [illegible]

[illegible]

[illegible]

The following [illegible]

[illegible]

(END)

[illegible]

(END)

[illegible]

[illegible] in NOCALED [illegible]

[illegible]

[illegible]

APPENDIX N

METHODOLOGY FOR CONTENT ANALYSIS OF NUIQSUT RESIDENTS' COMMENTS ON OIL DEVELOPMENT

Research Objectives

The objectives of this project are to analyze public testimony to better assess various social impacts of nearby oil development on the small indigenous community of Nuiqsut and to create a tool that will both facilitate analysis and lessen the inevitable impacts of future requirements to analyze social impacts in the region. Common questions at public meetings include ones such as, 'What did you guys do with our comments?' This is understood as meaning 'Are you including and giving extra weight not just to my testimony today but to all the valuable indigenous and traditional ecological knowledge that our elders shared with you throughout decades of meetings like this one, how can we be assured that you are, and why should we continue spending our time and sharing it without much evidence that you are using it in your decision-making?'

Methodology

This project used standard social science qualitative data analysis software (Atlas.ti). The purpose of this software is to help researchers uncover and systematically analyze complex phenomena hidden in unstructured data. The program provides tools that let the user locate, code, and annotate findings in primary data material, to weigh and evaluate their importance, and to visualize the often complex relations between them.

Through a lengthy and deliberate collaboration between the BLM sociocultural expert and an outside qualitative analysis specialist, a master codebook to guide the analysis of transcripts of 10 Nuiqsut public meetings on oil development[1] was designed. Initial creation of the codebook did use categories and aspects of subsistence and sociocultural impacts already identified in NEPA documents as prospective groups and codes, but it was mainly developed through intensive and iterative 'open coding' (also known as substantive or intuitive coding). In reviewing the data (in this case, public testimony of Inupiat), repeated ideas, concepts, or elements became apparent and were tagged with codes. As more data was collected and reviewed, codes were grouped into concepts and categories. This methodology allowed an organization of impacts into codes and categories to aggregate through the analysis of data instead of simply trying to find data that informed the limited categories of what were already suspected to be social impacts.

Determining the unit of analysis (amount of text) to code was challenging given the nature of the transcripts, but we decided to use what would generally be considered a paragraph as the unit. Transcriptions varied as to whether they were broken into blocks or paragraphs by subject or simply divided by speakers, regardless of the length of time one person spoke. In some cases we broke long sections of text into paragraphs. Capturing repetitions by a given speaker is important, as is capturing different ways the same code might come up.

The codebook and overall project was presented to and supported by the Native Village of Nuiqsut tribal council in August 2016.

[1] Testimony is from public meetings in Nuiqsut on the Alpine Satellite Development Project, the NPR-A Integrated Activity Plan, the GMT1 Supplemental EIS, scoping for the Nanushuk EIS, and the GMT1 Compensatory Mitigation Funds. A list of meetings is included at the end of this section.

The Codebook

The codebook consists of 47 intuitive codes grouped into 7 categories:

1. Public Health
2. Subsistence
3. Social Impacts of the Permitting Process
4. Physical Environment and Infrastructure
5. Miscellaneous and Important
6. Inupiat Culture and Way of Life
7. Economy

Two additional categories are not based on open or intuitive coding: one (*Names/Affiliations*) is for the personal names and, when known and appropriate, the affiliations of the speakers. Codes in these categories are not included in the analyses depicted below.

The second non-subjective category is *Places*. How testimony is coded into the *Physical Environment and Infrastructure* and the *Subsistence* groups is usually very straightforward, *Economy* is rarely subjective, and *Public Health* is only slightly more so.

A one-page version of the codebook serves as an overview and as a table of contents for the actual codebook[2], which includes descriptions of categories, rules for the use of each code, and, for each code, examples of testimony that were given that code. Much of the testimony refers to more than one subject and is co-coded appropriately, allowing the important analysis of frequencies of code co-occurrences.

[2] The full-length codebook is available on a case-by-case basis

Nuiqsut Oil Development Testimony Analysis Codes

Topic	Codes
Public Health	• Air quality • Noise • Food (niqipiaq & store-bought) • Water Health • Other human health issues
Subsistence	• Access/Land Loss/Avoidance • Abundance of Fish & Wildlife • Migration changes/localized displacement • Air Traffic • Roads • Hunting (competition, regulations, enforcement) • Native Allotments
NEPA Process/Social Impacts of Permitting	• Meetings • Comments • Pace • Capacity • Bureaucracy/difficulty/confusion • Rules • Lack of Sociocultural Analysis • Lack of Environmental Analysis • Distrust • Disenfranchisement • Conflict • Compensatory Mitigation
Physical Environment & Infrastructure	• Drill Pads and wells • Pipelines • Water Resources • Climate change • Legacy Wells • Vegetation • Oil Spill • Blowout • Bridges • Flooding • Seismic • Proximity of development • Offshore • Environment

Topic	Codes
Places	• Fish Creek • Nigliq Channel • Colville River • Judy Creek • Tingmiaqsigvik/Ublutuoch/The Y • Umiat • Teshekpuk Lake • Oliktok
Miscellaneous & Important	• Cumulative Impacts • Environmental Justice • Positive Impacts • Cultural Sites • Notable Quotations
Inupiaq Culture & Way of Life	• Inupiaq or Native way of life • Future generations • Traditional or Indigenous Knowledge
Economy/Jobs/Poverty	• Economy • Overcrowding
Names/Affiliations	• 53 Inupiaq residents of Nuiqsut identified by full names[3] • Native Village of Nuiqsut • Kuukpik Corporation • City of Nuiqsut • Arctic Slope Regional Corporation • North Slope Borough

The *Social Impacts of the Permitting Process* category is the main focus of this project and is the most difficult to code. It contains numerous codes that are more nuanced than the subjects typically analyzed in NEPA sociocultural systems sections. The codes are meant to provide insights into impacts that are often difficult to articulate and that pertain to a perpetual permitting process on a small minority population for nearby, large-scale development.

There are 12 codes within this group and several of the codes cover subjects that are closely related, thus the codebook includes extensive documentation of how to distinguish similar concepts. One such code in this group is *Bureaucracy* and it is designed to capture all comments that refer to:

- Difficulty or confusion with any aspects of the NEPA process or land management, including the documents themselves, any acronyms and jargon, what stage of the process the agency is at, and the significance of 'alternatives' presented in Draft NEPA documents.
- Confusion about the various land owners or managers, including which entities own or manage which land, how land conveyance occurs, and what the various authorities of the entities are.
- Confusion over the numerous advisory groups that exist on the North Slope

[3] There are also 5 unidentified speakers, many of whom are likely included in the 53 named speakers

- Complaints about information overload, frustration with red tape

A closely related code within the group is called *Community Capacity*. This code is used whenever people discuss how they are not adequately prepared to participate effectively in the process. This can be due to lack of trained and paid personnel, lack of time to deal with the process, lack of technology or equipment, or lack of ability to solicit legal advice.

Lack of Power/Disrespect/Disenfranchisement[4] is designed to capture other commonly expressed complaints about some aspect of the permitting process that is unfair or unjust and that occurs because the Inupiat have less power and agency. It is used for any complaints of racism, of inadequate consultation, that people's input is always solicited but seems to be ignored, that they have no real power to influence the ultimate decision (limited access to actual decision makers), and any complaints that they are exploited by industry or government agencies.

Distrust is the code used for a reference to distrust of the government, of industry, of the science and monitoring done on impacts (including the belief that there are too many and redundant studies, which is usually connected to aircraft traffic), when conflicts of interest are cited as reasons for distrust, and when people are concerned the science is being spun or edited to reduce the evidence of impacts.

Any testimony that refers to social and political conflict, including intra-community conflict that is exacerbated by the permitting process and intercommunity conflict due to appropriation of impact funds and levels of impacts experienced, is coded as *Conflict*.

Codes within this group that are much simpler to attribute include *Pace*, which is used for any comment that refers to the speed at which various projects are permitted and constructed. *Meetings* is the code for any reference to actual meetings (length, structure, scheduling, and number of, demands for, needs for food and door prizes at, etc.). Any testimony that is explicitly about testimony and public comments (how they are used, what has been done with all of them, please use previous ones, etc.) is coded with *Comments*. Any testimony that refers to inadequacy of the physical/environmental data used in the analyses is coded *Lack of Environmental Analysis,* and any reference to an EIS or agencies or researchers failing to study or include information about impacts to humans (including failure to weigh social impacts adequately) is coded as *Lack of Social/Cultural Analysis*. Most reference to funds that are directed to a community to be used to offset impacts (including the State of Alaska NPR-A Impact Mitigation funds, GMT1 funds, or the Northeast NPR-A Regional Mitigation Strategy) are coded as *Compensatory Mitigation*. All references to permit stipulations and requirements, laws and regulations, and monitoring and enforcement are coded as *Regulations and Enforcement*[5] (code shorthand: Rules).

Findings

At this initial stage of the project, the codebook is finalized and preliminary analyses can be done on the data. There is likely too little data (too few meetings) to analyze trends, but the existing data does

---

[4] *Disenfranchisement* is the most accurate word for this code. However, use of the term alone disenfranchises many residents, who are not familiar with it. It was felt that 'marginalize' was an even worse term and that 'lack of agency' would be quite confusing as well.

[5] The *Rules* code is used for any discussion of what the BLM refers to as avoidance and minimization mitigation.

provide evidence that social impacts of the perpetual permitting process are deeper and more complex than previous analyses have indicated.

The coding software allows numerous types of analyses to be extracted from the data sets of coded transcripts. The most simple is a spreadsheet that lists every code, depicts in columns how many times each code occurred in each meeting, and gives a total. This allows one to see whether an especially high code is high due to only one or two meetings where it may have been the subject of a lengthy discussion or whether it is high because it is something that reoccurs at most meetings in high frequency. In the transcripts coded to date, for example, *Compensatory Mitigation* (code shorthand: Mitigate) has the highest count (170) and it is clear that it is an important subject at all meetings, but the very high count is due to the fact that 3 of the 10 meetings included focused on the uses of GMT1 mitigation funds.

The second most frequent code (85 occurrences) is *Regulations and Enforcement* (code shorthand: Rules). Nearly every occurrence of this code is due to residents requesting stricter regulations and enforcement of them to protect subsistence resources and air and water quality. The top code with which *Regulations and Enforcement* co-occurs is *Migration changes/localized displacement.*

Access/Land Loss/Avoidance (code shorthand: Access), which is used whenever people speak of their ability to use traditional land, the loss of land, the avoidance of land due to infrastructure and activities, the need to travel further to hunt or fish, and land claims and title to land is the third highest code (81 occurrences).

Both the *Regulations and Enforcement* and *Access/Land Loss/Avoidance* codes are spread more evenly over all meetings. When more meetings are included in the analysis and outliers are accounted for, it is hoped that basic code counts will allow for a robust analysis of trends.

Table 1 Code Counts for Nuiqsut Residents' Testimony on Oil Development

Topic	P 1: 2004_2_10 Draft Alpine Satellite Development Plan	P 2: 2004_8_9 Northeast NPR-A Amendment Draft EIS	P 3: 2010_9_16 NPR-A IAP Scoping	P 4: 2012_5_16 NPR-A Draft IAP	P 5: 2014_3_12 GMT1 EIS Scoping	P 6: 2015_5_30 GMT1 Compensatory Mitigation Funds	P 7: 2015_9_22 GMT1 Compensatory Mitigation Funds	P 8: 2016_3_21 Nanushuk EIS scoping meeting	P 9: 2016_4_22 Nuiqsut trilateral on GMT1 Compensatory Mitigation Funds	P10: 2016_4_22 GMT1 Compensatory Mitigation Funds	TOTALS:
Abundance of Fish & Wildlife	8	4	3	3	6	3	3	6	3	2	41
Access/Land Loss/ Avoidance	16	5	7	18	8	4	7	8	5	3	81
Air Quality	5	0	1	8	3	5	0	8	0	1	31
Air Traffic	6	2	3	0	10	0	0	8	0	1	30
Allotment	1	3	1	2	0	0	0	1	0	0	8
Blowout	0	0	0	2	1	2	1	8	0	2	16
Bridges	10	0	2	0	1	1	0	0	0	0	14
Bureaucracy	4	3	11	4	2	4	21	4	9	1	63
Community Capacity	6	0	0	1	1	0	2	0	7	0	17
Climate Change	1	0	1	1	2	0	0	0	0	0	5
Colville River	6	1	4	3	2	2	4	11	13	4	50
Comments	5	3	1	9	0	2	1	2	0	1	24
Conflict	0	0	3	1	4	11	36	6	7	0	68
Cultural Sites	5	2	0	1	0	0	0	0	0	0	8
Cumulative Impacts	12	4	2	6	6	3	7	6	1	2	49
Lack of Power/Disrespect/ Disenfranchisement	10	1	1	3	1	2	17	4	1	0	40
Distrust	9	1	4	9	4	2	14	11	1	2	57
Economy/jobs/ Poverty/royalties	14	6	1	9	5	14	2	7	3	1	62
Environmental Justice	1	0	0	0	0	2	1	0	0	1	5
Fish Creek	5	1	2	2	4	2	4	0	3	6	29
Flooding	5	0	0	0	0	1	0	4	0	0	10
Food (Native & Store-bought)	2	1	1	8	2	0	0	5	1	1	21
Future Generations	7	6	0	9	10	5	6	8	2	0	53
Additional Human Health Issues	5	3	2	1	1	5	1	4	0	0	22
Hunting (competition, regs, Enforcement)	1	0	3	0	0	1	4	3	18	0	30

Topic	P 1: 2004_2_10 Draft Alpine Satellite Development Plan	P 2: 2004_8_9 Northeast NPR-A Amendment Draft EIS	P 3: 2010_9_16 NPR-A IAP Scoping	P 4: 2012_5_16 NPR-A Draft IAP	P 5: 2014_3_12 GMT1 EIS Scoping	P 6: 2015_5_30 GMT1 Compensatory Mitigation Funds	P 7: 2015_9_22 GMT1 Compensatory Mitigation Funds	P 8: 2016_3_21 Nanushuk EIS scoping meeting	P 9: 2016_4_22 Nuiqsut trilateral on GMT1 Compensatory Mitigation Funds	P10: 2016_4_22 GMT1 Compensatory Mitigation Funds	TOTALS:
Inupiaq Culture	16	6	2	18	7	2	9	4	3	4	71
Judy Creek	0	0	0	0	1	0	0	0	0	0	1
Lack of Environmental Analysis	21	0	4	3	12	1	1	3	4	2	51
Lack of Social Analysis	7	1	1	4	3	2	8	2	3	2	33
Legacy Wells	0	0	0	1	0	1	0	3	0	0	5
Meetings	0	2	1	5	2	2	0	1	0	1	14
Migration changes	22	9	3	9	6	3	3	10	1	0	66
Compensatory Mitigation	5	7	4	6	6	28	38	6	58	12	170
Nigliq Channel	9	0	1	2	1	2	0	4	1	2	22
Noise	1	0	0	0	0	1	0	1	0	0	3
Offshore Oil Development	0	0	0	1	1	0	1	0	0	0	3
Oliktok	0	0	0	0	0	0	0	0	0	0	0
Overcrowding	0	0	0	4	0	1	0	0	1	0	6
Pace	2	2	2	3	0	1	3	4	4	2	23
Drill pads & wells	4	0	0	0	2	1	1	5	0	0	13
Pipelines	19	4	6	5	1	0	0	3	0	0	38
Positive Impacts	3	4	2	0	3	0	0	1	23	1	37
Proximity of development	11	1	1	3	4	1	2	7	0	0	30
Roads	14	0	3	2	6	1	1	3	27	1	58
Regulations and Enforcement	14	15	5	7	6	8	7	16	6	1	85
Seismic Exploration	0	0	0	1	0	0	0	0	0	0	1
Oil Spills	3	0	2	0	1	2	0	6	0	2	16
Teshekpuk Lake	1	3	1	2	1	0	3	0	0	0	11
Tingmiaqsigvuk	0	0	0	0	0	0	0	0	0	0	0
Traditional Knowledge	9	1	0	3	4	1	0	0	0	0	18
Umiat	1	0	1	1	1	0	0	1	2	0	7
Vegetation	1	0	0	0	0	0	0	0	0	0	1
Water resources	2	0	3	0	1	0	0	0	0	0	6
Water Quality	0	0	0	2	1	1	0	0	3	1	8
Totals	**309**	**101**	**95**	**182**	**143**	**130**	**208**	**194**	**210**	**59**	**1631**

Top code counts can also be depicted with bar graphs that differentiate meetings by color:

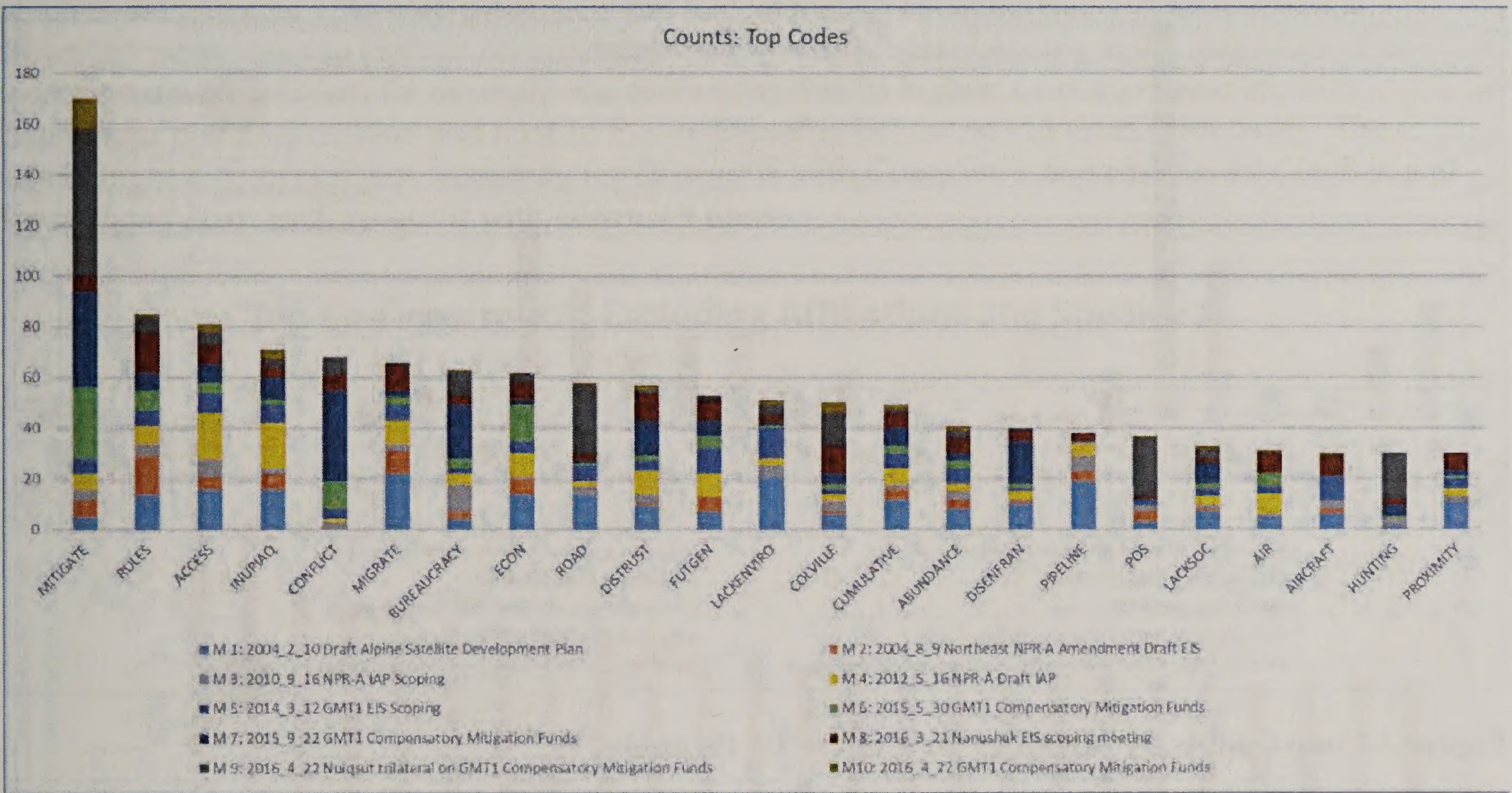

Figure 1 Top Code Counts by Meeting

Code counts by meeting allows for a greater understanding of which meetings may be outliers:

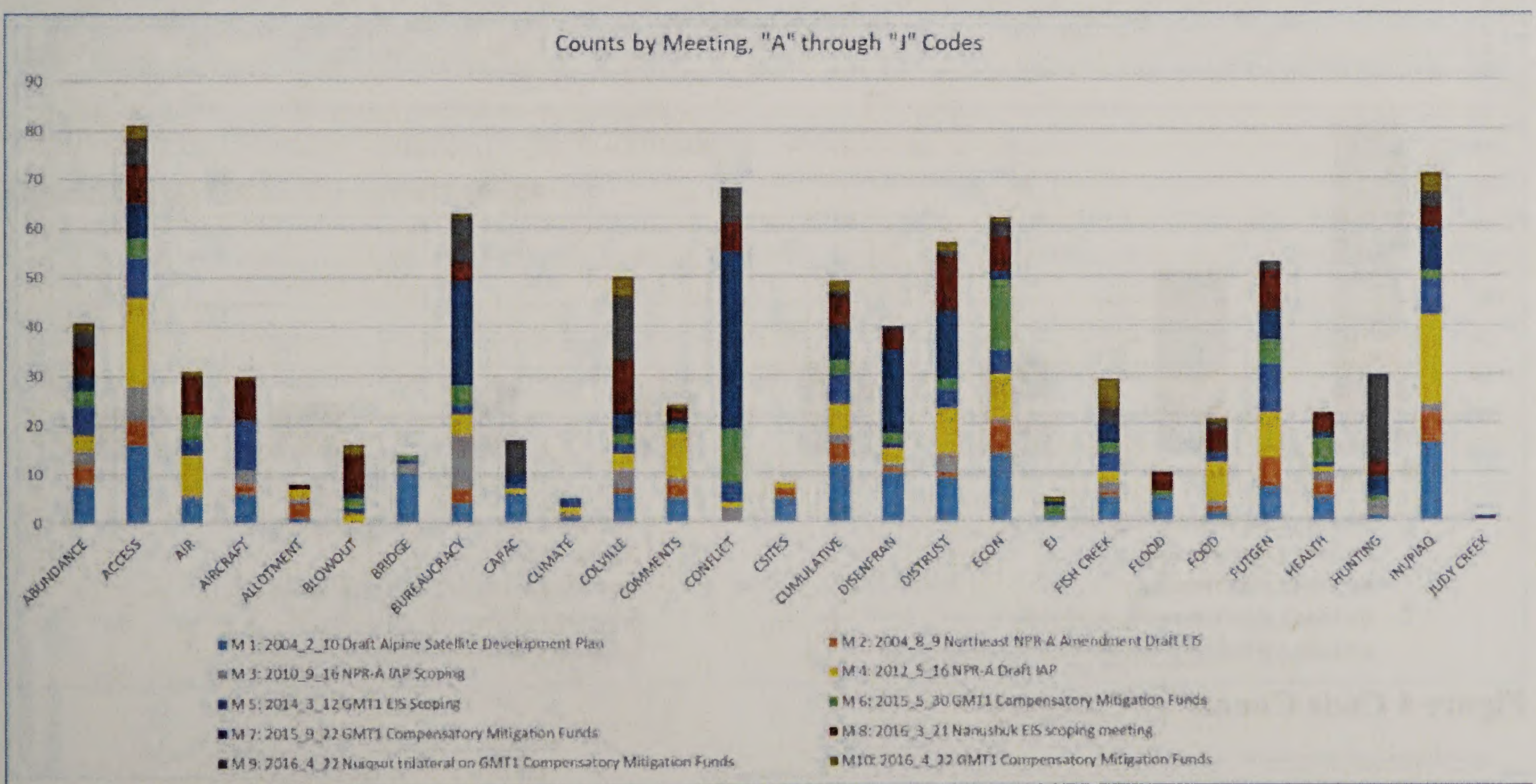

Figure 2 Code Counts by Meetings for Codes "A" through "J"

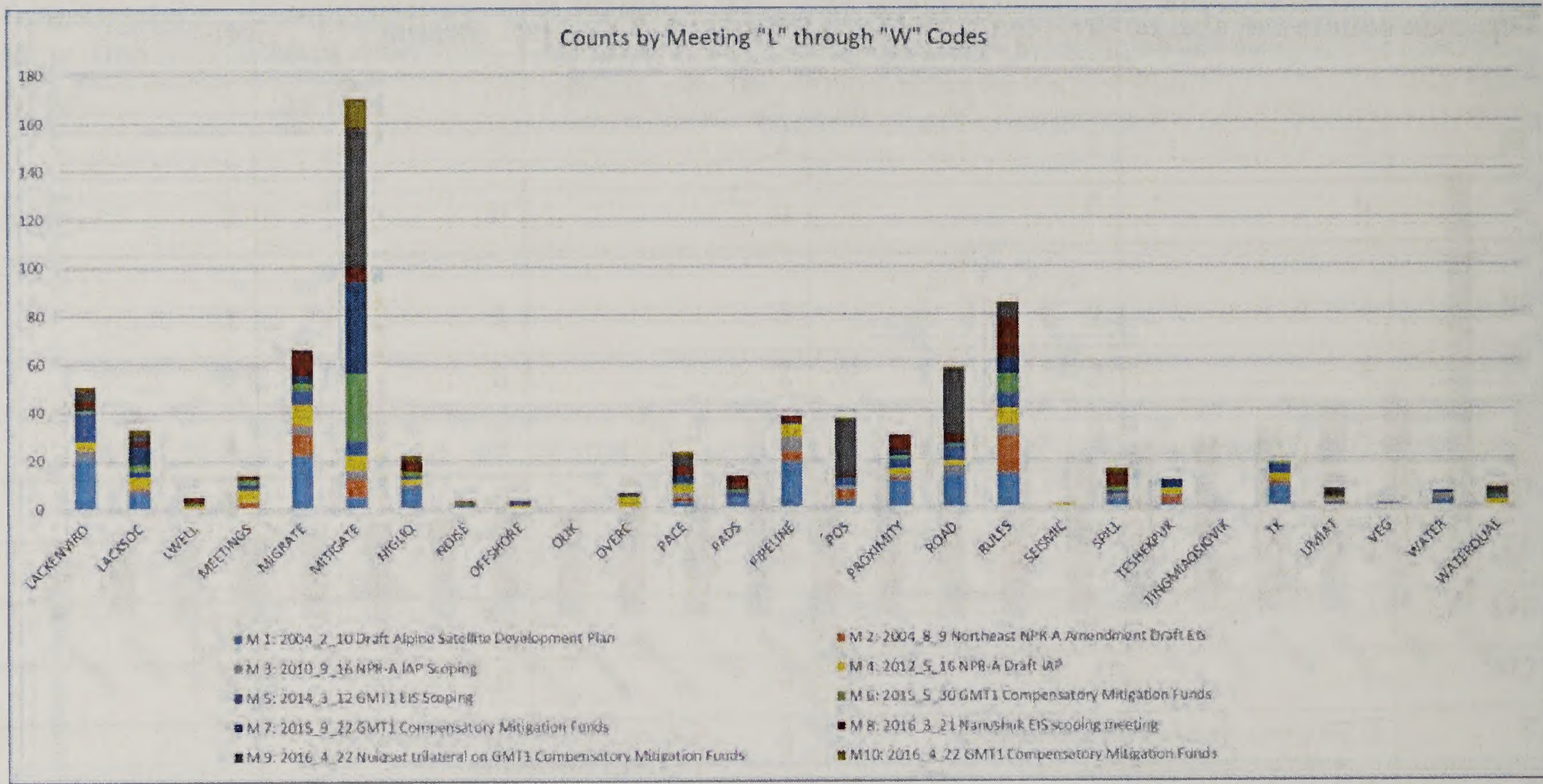

Figure 3 Code Counts by Meetings for Codes "L" through "W"

Depicting the code counts by code category indicates that despite the extra attention the permitting process was given at recent meetings on the RMS, codes in that category tend to occur at a high frequency at most meetings.

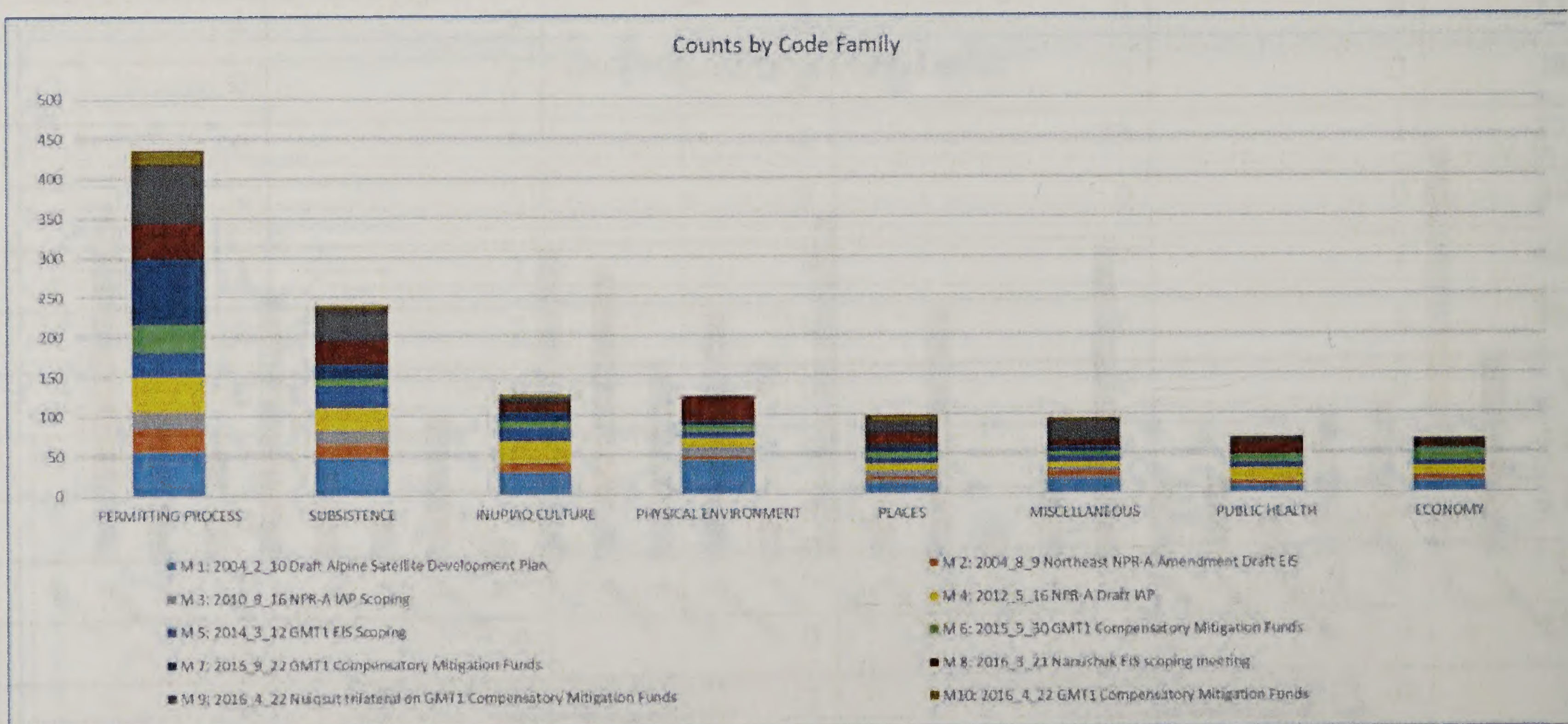

Figure 4 Code Counts by Category

As mentioned above, one of the most useful analyses that can be run with the software is exploring which codes co-occur with each other. One can look at the top co-occurrences of all codes as is shown below, or one can analyze co-occurrences of specific codes. Looking at the frequency of co-occurrences with *Distrust*, for example, the data shows that its highest co-occurrences are with *Regulations and Enforcement* and *Lack of Power/Disenfranchisement* (14 times with each). The second highest co-occurrence frequency for *Distrust* is with *Cumulative Impacts*, *Social Conflict*, and *Access/Land Loss*: each co-occur with *Distrust* 9 times.

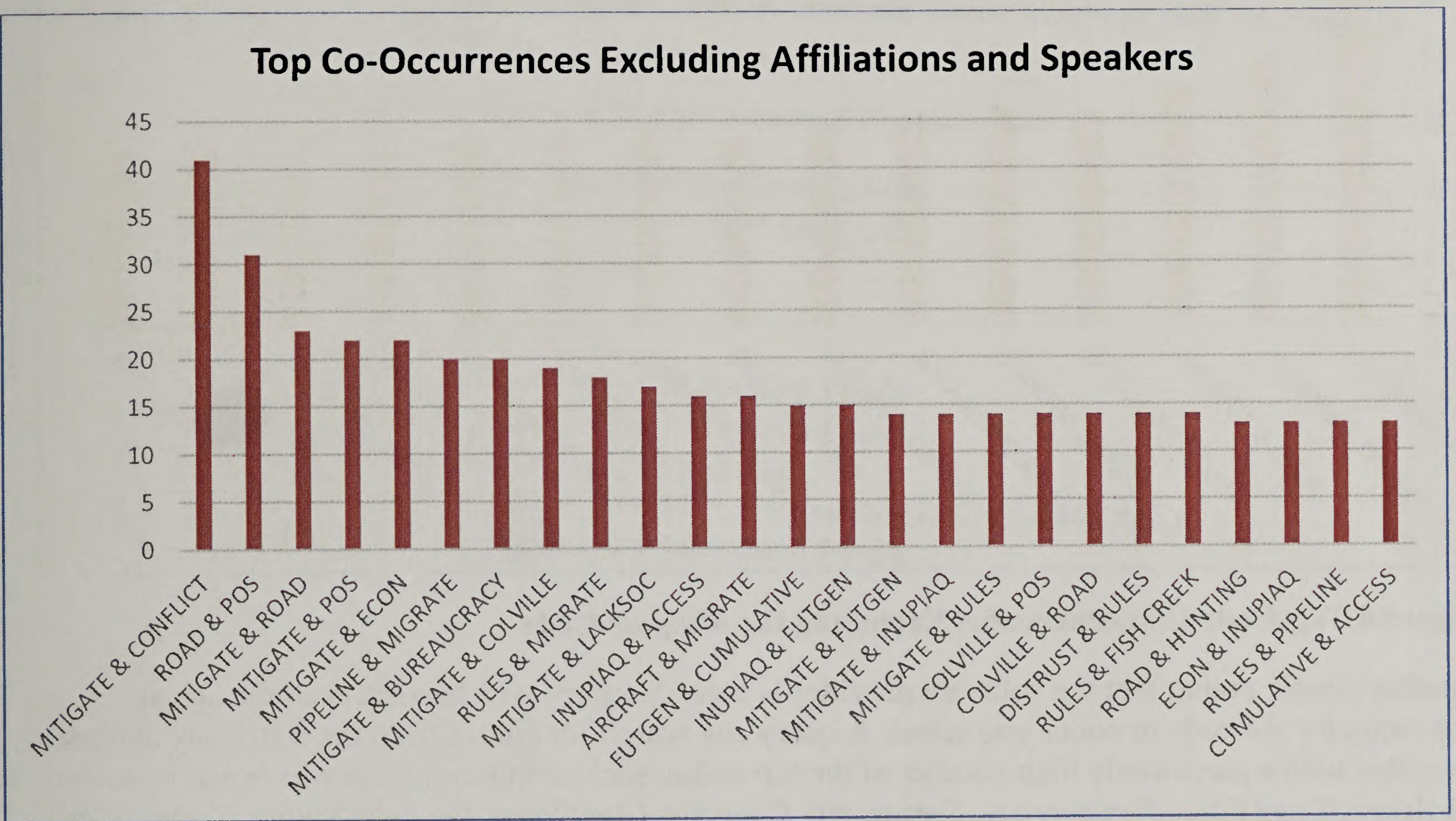

Figure 5 Top Code Co-occurrences

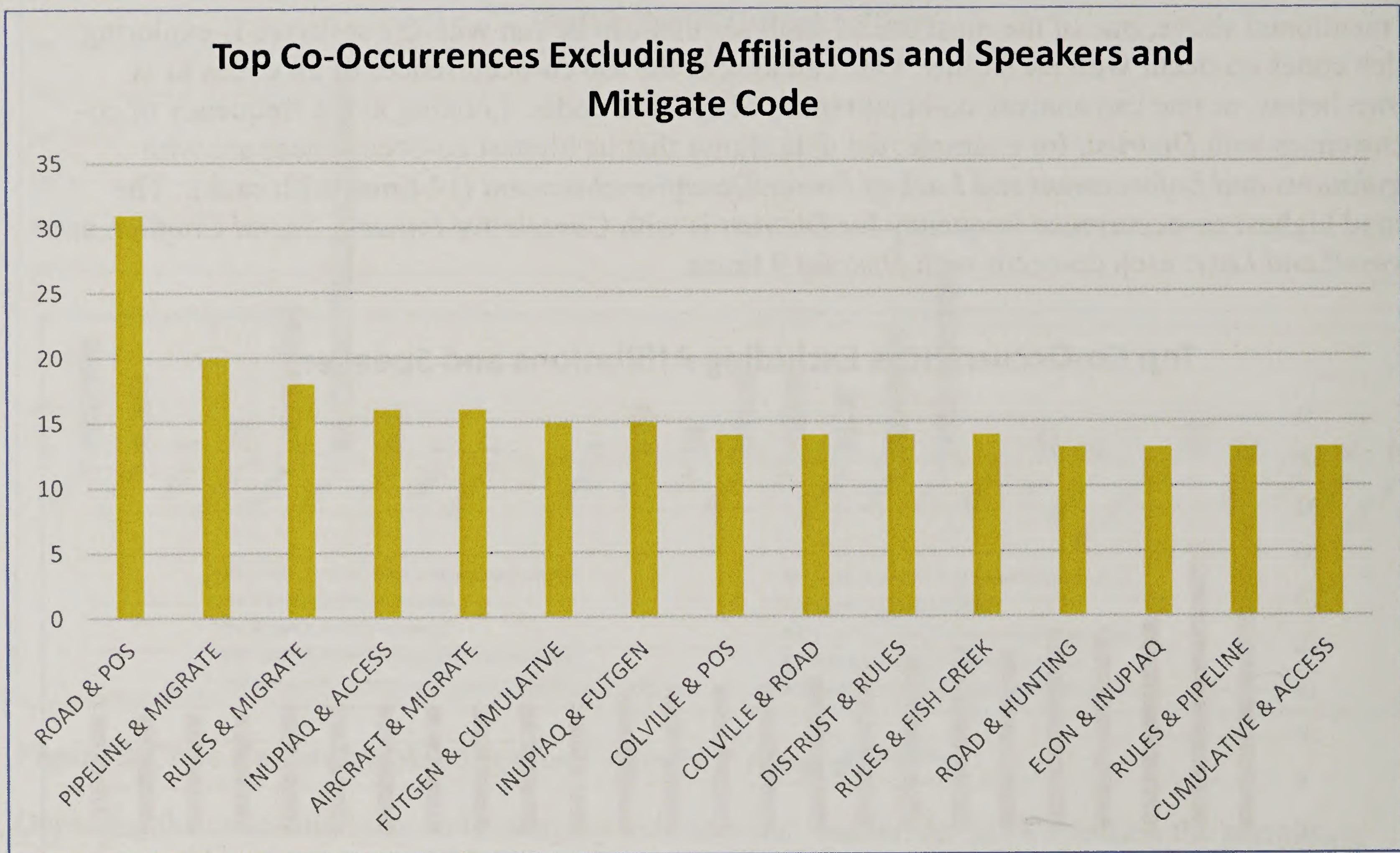

Figure 6 Top Code Co-occurrences Excluding the *Mitigate* Code

Another simple output that the software provides is a query report, which extracts all the actual testimony for the code or codes you select. A query can search for quotes from the testimony that are co-coded with a particularly high number of the top codes, such as this comment which was co-coded for *Access/Land Loss*, *Bureaucracy*, *Community Capacity*, *Cumulative Impacts*, *Future Generations*, and *Inupiaq Culture*:

> *"And I didn't have a written comment, but I just want to say that I represent the elders who has no education on reading the EIS draft. They have taught us to live a good life, subsistence life, the way Inupiaqs are and that's who we are, and that's who we will continue to be when you leave. And I want to say that where were the agencies 30 years ago when Prudhoe Bay was being developed? Where were the agencies for our elders who I know have lost their rights, hunting rights over at Kuparuk, some on along the Sagavanirktok River? Where were the agencies to protect our elders who had once lived in Prudhoe Bay? Where were the agencies when Sarah Kunaknana who I know has a sod house in Prudhoe Bay that she hasn't gone to see 30 years and was told by industry that she's -- she can't go over there? She would for one time would love to go see her sod house, which is in Prudhoe Bay. Where were the agencies when my mom and other people from Oliktok were taken -- driven out of there because of industry?"*

Next Steps

The core transcripts for this first stage are public meetings[6] in Nuiqsut on onshore oil development. Subsequent stages of the project will expand the scope of meetings to allow users to compare and contrast data from those with the core transcripts. The other types of transcripts will include Nuiqsut public meetings on offshore oil development, public meetings in other North Slope Borough communities on oil development, NPR-A Subsistence Advisory Panel meetings, all-stakeholder Regional Mitigation Strategy workshops, NPR-A Working Group meetings, and other sets of transcripts that are available.

Nuiqsut Public Meetings Analyzed in First Stage of Project

1. 2004_2_10 Draft Alpine Satellite Development Plan
2. 2004_8_9 Northeast NPR-A Amendment Draft EIS
3. 2010_9_16 NPR-A IAP Scoping
4. 2012_5_16 NPR-A Draft IAP
5. 2014_3_12 GMT1 EIS Scoping
6. 2015_5_30 GMT1 Compensatory Mitigation Funds
7. 2015_9_22 GMT1 Compensatory Mitigation Funds
8. 2016_3_21 Nanushuk EIS scoping meeting
9. 2016_4_22 Nuiqsut trilateral on GMT1 Compensatory Mitigation Funds
10. 2016_4_22 GMT1 Compensatory Mitigation Funds

[6] One of the meetings included in the first ten (2016_4_22 Nuiqsut trilateral on GMT1 Compensatory Mitigation Funds) was technically not public; it was between BLM and numerous representatives of the three entities (Tribe, City, and Corporation). This transcript is included for now but perhaps should be analyzed separately for comparative purposes in the future. The 'Code Count by Meeting" chart shows that this meeting, as would be expected, focused heavily on mitigation.